HISTORICAL ECOLOGY PROGRAM
CONTRIBUTION NO. 664 • JUNE 2012

UPPER PENITENCIA CREEK HISTORICAL ECOLOGY ASSESSMENT

June 2012

By the San Francisco Estuary Institute

Erin Beller

Robin Grossinger

Maika Nicholson

Micha Salomon

Design and layout by Ruth Askevold

Suggested Citation:

Beller EE, Grossinger RM, Nicholson M, Salomon MN. 2012. Upper Penitencia Creek Historical Ecology Assessment. A report of SFEI's Historical Ecology Program, SFEI Publication #664, San Francisco Estuary Institute, Richmond, CA.

Report is available on SFEI's website, at http://www.sfei.org/UpperPen_HE.

Front cover: "Penitencia Creek, near Alum Rock, San Jose, Cal.," circa 1900. Courtesy of the San Jose Public Library, California Room.

Table of Contents

Acknowledgments

This assessment was funded by Waste Management of California, Inc. Thanks to Trish Mulvey, Marc Klemencic, Molly Martindale, Bill DeJager, and Gary Stern for their help in developing the concept for the project. Bill DeJager and Robert Leidy provided technical review.

We would like to express our appreciation to the volunteers and staff at the historical societies, libraries, archives, and agencies where we gathered data. Particular thanks to Susan Snyder at The Bancroft Library, Susan Sarantopoulos at the Bureau of Land Management, Gwen Gee and Angela Schultz at the Office of the Santa Clara County Surveyor, and Trista Raezer at the Santa Clara County Archives.

Executive Summary

Upper Penitencia Creek drains a 24 square mile area within the Coyote Creek watershed in Santa Clara County, California. Like many creeks in the Santa Clara Valley, Upper Penitencia Creek has experienced extensive modifications to its hydrology, geomorphology, and ecology over the past 250 years, particularly along its course across the valley floor.

This report uses archival data to document historical (mid-19th century) conditions along Upper Penitencia Creek as it flowed through the Santa Clara Valley. Findings confirm and advance the historical analyses of the *Coyote Creek Watershed Historical Ecology Study* (Grossinger et al. 2006) and the *Upper Penitencia Creek Feasibility Study: Draft Functional Assessment* (DeJager and Martel 2006). We found that Upper Penitencia Creek exhibited several heterogeneous reaches characterized by distinct riparian communities and dry season hydrology: moving downstream, conditions transitioned from mixed riparian forest and perennial flow in the canyon reach (Alum Rock Park) to a sycamore-dominated riparian corridor and intermittent flow conditions to at least the upstream Mabury Road crossing. At the historical terminus of the creek, an extensive wetland complex composed of freshwater marsh, seasonally flooded wetlands, and large willow thickets separated Upper Penitencia Creek from Coyote Creek and Lower Penitencia Creek. Throughout, we found that the creek exhibited a relatively low sinuosity, though we did document the loss of former side channels.

Our findings detail numerous aspects of Upper Penitencia Creek that have changed over time, the most notable arguably being the shift to a more perennial hydrology (sustained by summer releases and imported water) and the diversion of Upper Penitencia Creek into Coyote Creek in the early 1850s. Despite the many modifications, however, aspects of the former creek have persisted in even the most urbanized reaches of Upper Penitencia Creek. In particular, the persistence of a sycamore-dominated riparian canopy on the valley floor upstream of Capitol Avenue is notable, as is the relative stability of channel planform over this time frame. This study reveals the wide range of local conditions found along the creek historically, providing context for understanding the current system and suggesting possibilities for how to manage the creek in the future.

Introduction

This report documents aspects of Upper Penitencia Creek's hydro-geomorphology and riparian ecology prior to major Euro-American modification, as synthesized from historical records. It describes in general terms the historical channel alignment, dry season hydrology, and riparian corridor of the creek as interpreted from early maps, textual records, and photographs. It also explores the nature and timing of perhaps the most significant change to the system during the past 200 years: the creation of a direct connection with Coyote Creek.

The goal of this research is to provide accurate, readily available information about the creek's historical character to aid the evaluation of present day conditions and to provide a foundation for management decisions. In particular, this project was designed to fill information gaps identified in discussions about flood protection, dry season flow releases, riparian vegetation management, and fisheries management. Agencies such as the Army Corps of Engineers, Santa Clara Valley Water District, National Marine Fisheries Service, California Department of Fish and Game, San Francisco Bay Regional Water Quality Control Board, and others are involved in a variety of management decisions which will benefit from an understanding of the history of the stream.

The research presented here is informed by previous historical research completed in the watershed, in particular the *Upper Penitencia Creek Feasibility Study: Draft Functional Assessment* (DeJager and Martel 2006) and the *Coyote Creek Watershed Historical Ecology Study* (Grossinger et al. 2006). This effort refines and adds detail to descriptions of the creek outlined in these reports, supplementing them with additional sources and analysis.

The geographic scope of this project emphasizes the lowest four miles of Upper Penitencia Creek: its course through the Santa Clara Valley from the Los Buellis Hills to Coyote Creek. Limited information is also included for the lowest canyon reach to provide context for our discussion.

Our research focuses on Upper Penitencia Creek as it existed during the mid-19th century. This target date reflects what is generally the earliest available, spatially accurate documentation of creek conditions in the area. This means that the maps and texts analyzed in the following pages do not depict the creek prior to all Euro-American modifications; the Santa Clara Valley was already well settled and cultivated by this time. However, the information outlined here does provide an understanding of the historical character of the creek prior to the substantial modifications of the late 19th and 20th centuries, as well as of the timing and magnitude of changes that have taken place over this time.

Upper Penitencia Creek has locally significant potential for stream restoration, and there are a number of planned or ongoing environmental

Sycamores in the riparian corridor along Upper Penitencia Creek east of Noble Avenue, November 2011.

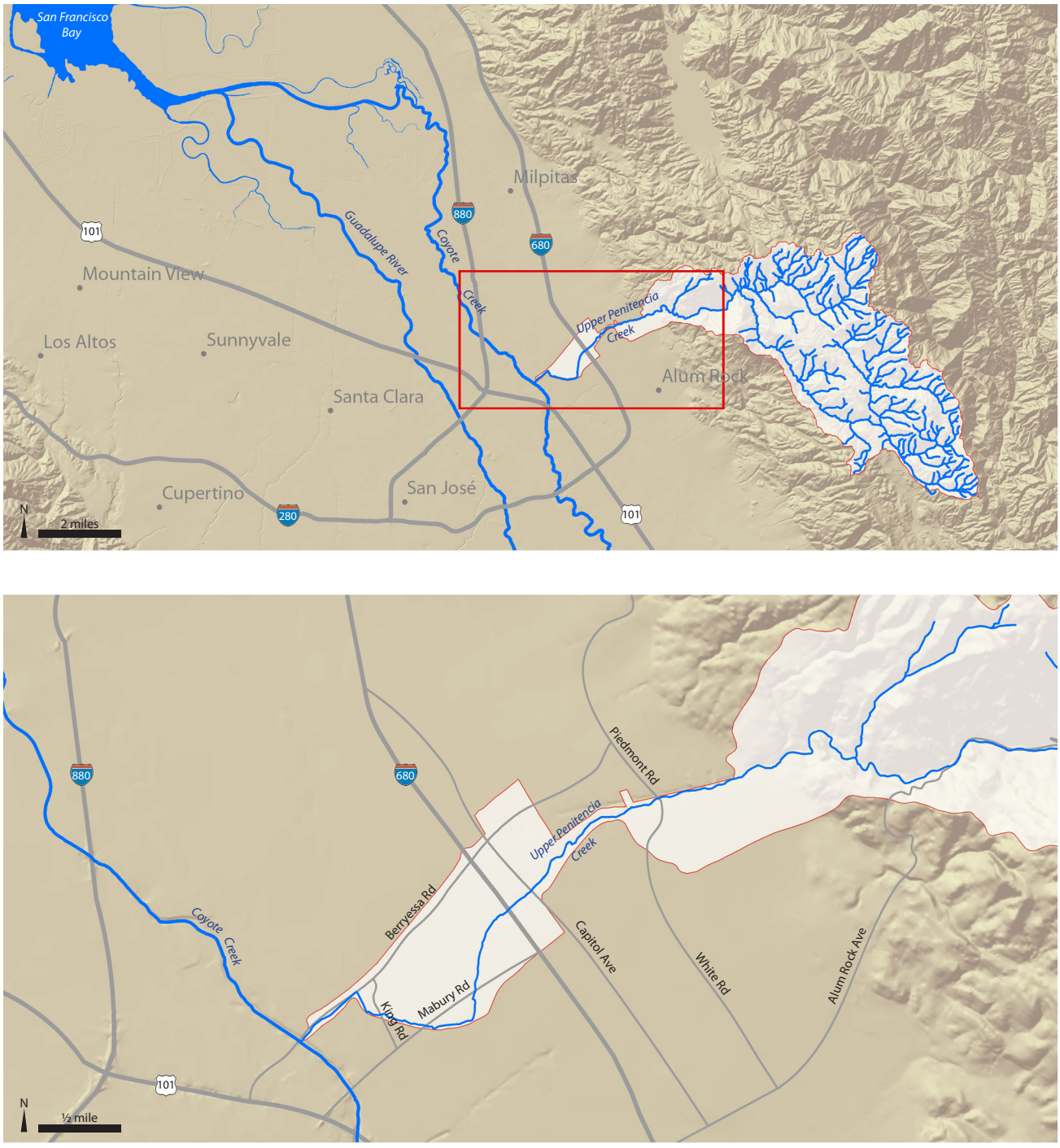

Fig. 1. Upper Penitencia Creek flows westward from the hills, before joining Coyote Creek at Berryessa Road. It drains a 24 square mile watershed (top). This study examines the portion of Upper Penitencia Creek that crosses the Santa Clara Valley floor, in addition to the lowest few miles of its course through the hills, roughly the extent shown (at bottom).

restoration and management efforts in the watershed. It is our hope that in revealing a more detailed picture of the historical nature of the system, this report will establish a strong basis for the current and future management of the creek.

ENVIRONMENTAL SETTING

Upper Penitencia Creek drains a 24 square mile area within the larger Coyote Creek watershed in Santa Clara County (fig. 1). Most of Upper Penitencia Creek's watershed (88%) is composed of the steep slopes and narrow canyons of the Diablo Range (SCBWMI 2000). Its principal tributary is the perennial Arroyo Aguague, which has retained a form of Upper Penitencia Creek's Mexican-era name (see page 6) and contributes most of the creek's flow (Young et al. 2003).

Upper Penitencia Creek currently runs for approximately eleven miles from its headwaters in the Diablo Range to its confluence with Coyote Creek. It flows through Cherry Flat Reservoir (constructed in 1936 to supply water to Alum Rock Park during the summer; Arbuckle 1986) and Alum Rock Park before exiting the hills onto the valley floor. From the mouth of the canyon, Upper Penitencia Creek flows westward across the Santa Clara Valley floor and through the city of San Jose for about four miles before joining Coyote Creek just upstream of the Berryessa Road bridge, approximately 10 miles upstream of San Francisco Bay.

Like many creeks in the Santa Clara Valley, Upper Penitencia Creek has experienced extensive modifications to its hydrology, geomorphology, and ecology over the past 250 years, particularly on the valley floor. Its hydrology is currently partially controlled by Cherry Flat Reservoir in the upper watershed, by off-channel percolation ponds which divert flow on the valley floor, and by imported water from the South Bay Aqueduct. Early farmers adjacent to the creek altered the channel morphology by building levees, straightening and channelizing the creek, and even creating the previously non-existent connection between Upper Penitencia and Coyote creeks (see page 13). These and other changes in water and land use in the watershed have had broad impacts on the transport of water and sediment in the system, as well as on the physical form and riparian ecology of the creek and its floodplain. (For more information on changes to Upper Penitencia Creek and linkages to contemporary conditions, see Stillwater Sciences 2006 and DeJager and Martel 2006.)

Despite these modifications, even the most urbanized reaches of Upper Penitencia Creek still retain many natural aspects. These include the presence of a gravel/cobble substrate (DeJager and Martel 2006), at least partial access to adjacent floodplains (Jordan et al. 2010), and a nearly continuous riparian forest along the creek connecting the Diablo Range to Coyote Creek, one of the few remaining riparian corridors to do so (Young et al. 2003). The relatively undammed stream is also considered to be an "essential stream" with important habitat value for Bay Area steelhead populations (Becker et al. 2007). It also supports a diverse assemblage

of other native fishes, including Pacific lamprey, hitch, California roach, Sacramento pikeminnow, Sacramento sucker, Chinook salmon, threespine stickleback, prickly sculpin, and riffle sculpin (R. Leidy, pers. comm. 4/2012).

METHODS

The measurements, opinions, and observations of early surveyors, tourists, local residents, and photographers traveling along Upper Penitencia Creek form the foundation of this study. The following paragraphs provide an overview of the methods used to acquire, interpret, and synthesize these historical data. More details on this process are presented in Grossinger et al. (2006) and Beller et al. (2010).

We collected information about historical creek conditions from an array of sources. Assembled materials included written accounts (e.g., Spanish explorer's accounts, Mexican land grant case court testimonies, General Land Office records, newspaper articles, and early travelogues), photographs (landscape and aerial), and maps (e.g., Mexican land grant maps, property maps, soil surveys, and U.S. Geological Survey maps). The search for relevant historical documents was extensive and thorough. However, additional clues always remain undiscovered, and it is probable that additional sources outside the scope of this project (e.g., local newspaper clippings) will contain supplementary information.

Sources collected for the broader *Coyote Creek Watershed Historical Ecology Study* (Grossinger et al. 2006) and the *Historical Vegetation and Drainage Patterns of Western Santa Clara Valley* report (Beller et al. 2010) were reviewed for information relevant to the system. A photomosaic of 1939 aerial photographs created for the Coyote Creek watershed study covers the reaches of interest on Upper Penitencia Creek, and was used for this project. General Land Office (GLO) Public Land Survey notes covering the region and spanning from 1854 to 1879 were collected and entered into a GIS layer using a tool developed by the Forest Ecology Lab at the University of Wisconsin-Madison. Additional data were also discovered in online historical databases and during additional trips to archives, including the Bureau of Land Management, the Office of the Santa Clara County Surveyor, the Santa Clara County Archives, and The Bancroft Library.

Once collected, we examined historical documents for evidence of creek characteristics prior to significant Euro-American modification. Maps, photographs, and textual data were organized by topic and by reach. This use of numerous sources, often overlapping in geography and content, allowed us to compare a diverse array of documents pertaining to the historical character of the creek. Using this approach, each document provided additional nuance and perspective, allowing us to assess the accuracy of individual documents and synthesize across various records to create a more accurate interpretation of historical characteristics.

Preliminary mapping of Upper Penitencia Creek's historical channel alignment and surrounding habitats (notably, the wetland complex associated with the terminus of the creek) was completed as part of the Coyote Creek watershed study. Mapping was completed in a geographic information system (GIS) using ArcGIS (ESRI) software. By georeferencing historical maps, textual data, and early aerial photographs, we were able to compare historical layers to each other and to contemporary aerial photography and maps. Reliable evidence for feature location and extent was digitized from each source, then synthesized into a single picture of landscape pattern based on historical evidence and landscape form (e.g., topography, surficial geology, and soils). This process allowed us to efficiently synthesize complex arrays of spatially explicit data and more accurately map each feature. To record variations in source data and confidence level, we used a set of metrics developed to assess the interpretation, size/shape, and location certainty associated with different features (see Grossinger et al. 2006, 2007).

In this study, we built upon this initial mapping effort to provide a more detailed, comprehensive view of Upper Penitencia Creek and its associated wetland complex. We updated the 2006 mapping to reflect additional sources and (where applicable) to reflect the most current methods in historical ecology synthesis. Mapping of the historical channel of Upper Penitencia Creek used the modern creek layer (as mapped by the Bay Area Aquatic Resource Inventory) as a base layer. We modified the creek where earlier sources showed historical position to differ by at least 15 meters (50 feet) from the modern creek alignment.

Some aspects of the creek were analyzed but not represented in the GIS mapping, due to a lack of spatially explicit records. In particular, the creek's summer hydrology and the character of its riparian vegetation were analyzed independently from the GIS and are described in narrative form in this report. Additional details describing changes in planform and channel connectivity to Coyote Creek are also addressed here, providing supplementary information to explain and support the patterns illustrated in our historical mapping. We searched for, but did not find, relevant historical materials describing early steelhead use of the stream.

Stream Connectivity and Modification History

Upper Penitencia Creek has an unusually complicated hydrologic history. Upper and Lower Penitencia creeks were seasonally connected prior to 150 years ago, sharing winter flows through a series of sloughs and freshwater wetlands. However, their channels were discontinuous enough to be considered separate creeks with completely different names – Arroyo Aguaje (upper) and Penitencia Creek (lower). Paradoxically, though today's Upper Penitencia Creek is a completely independent system from Lower Penitencia Creek, now they do share a name, an artifact presumably reflective of a temporarily shared hydrology before their full disconnection during the later 19th century.

This section discusses the nature and timing of changes to Upper Penitencia Creek's connectivity, both to Coyote Creek and Lower Penitencia Creek.

ARROYO AGUAJE AND PENITENCIA CREEK

What is now known as Upper Penitencia Creek was known in the 19th century as Arroyo Aguaje (an *aguaje* is a spring or watering place; locally variably spelled Aguage or Aguague). A form of the name has been retained by Arroyo Aguague, a tributary to Upper Penitencia Creek. Today's Lower Penitencia Creek was known as Penitencia Creek as early as 1840, so named for a nearby adobe used during mission times by priests from Mission San José and Mission Santa Clara to gather and exchange confessions (Gudde and Bright 1998).

[Upper Penitencia Creek] spreads in a large willow swamp along the bank of the Coyote…the Penitencia Creek which empties into the bay of San Francisco has its source in the swamp referred to.

—HEALY 1861B

The two creeks were separated by a substantial complex of seasonal and perennial freshwater marsh and groves of willows and other hydrophilic trees, stretching along the east side of Coyote Creek from today's Murphy Avenue southward past Mabury Road (fig. 2). This area marked the 19th century termination of Upper Penitencia Creek/Arroyo Aguaje, whose channel lost definition as the creek spread into marshes and thickets. This area was described as the "*derramadera* or outspreading of the [Arroyo] Aguage through the *sausal*" (Sibrian 1858); residents noted that the creek "lost itself in the *sausal*" (Bernal 1858, Goodrich 1858). (A *sausal* is a willow grove or thicket.)

The same wetland complex was also the source of today's Lower Penitencia Creek, whose beginning was about one to one and a half miles from the mouth of Upper Penitencia Creek (Tracy 1858). Though Upper and Lower

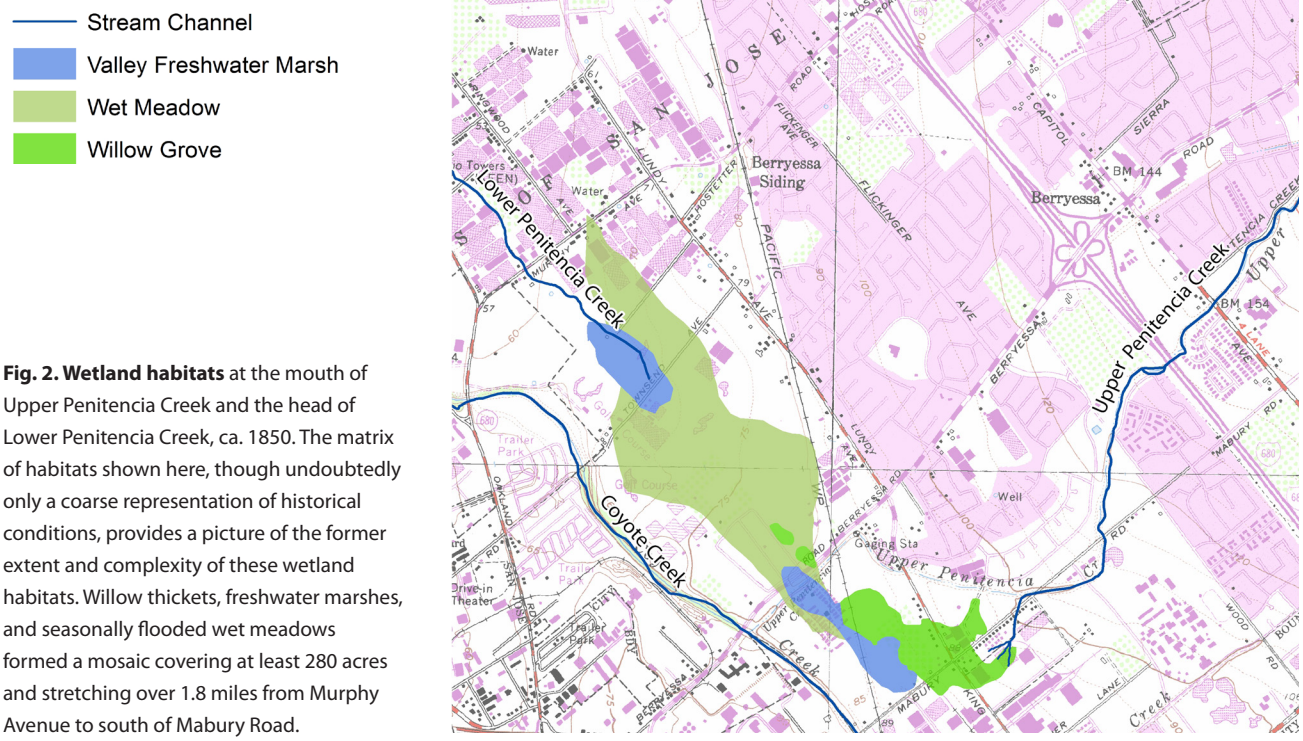

Fig. 2. Wetland habitats at the mouth of Upper Penitencia Creek and the head of Lower Penitencia Creek, ca. 1850. The matrix of habitats shown here, though undoubtedly only a coarse representation of historical conditions, provides a picture of the former extent and complexity of these wetland habitats. Willow thickets, freshwater marshes, and seasonally flooded wet meadows formed a mosaic covering at least 280 acres and stretching over 1.8 miles from Murphy Avenue to south of Mabury Road.

Penitencia creeks were not directly connected via a defined channel, to 19th century observers the relationship between the two creeks was clear, and historical sources consistently note a hydrologic connection between them. Tracy (1858), when asked where the upper creek would "empty itself" prior to 1852, stated that the stream "sunk in what they called the *sausal*…it rose then a mile or a mile and a half from where it sunk and made an arroyo that was called the Penitencia." When pushed during the cross-examination to justify how he knew that the sinking Upper Penitencia/Arroyo Aguaje was the source "that rose to make the Penitencia," he responded "I have no way of knowing but from the location of the country and the appearance." Goodrich (1858) described that the creek "lost itself in the *sausal* and then it came out as a stream again [Lower Penitencia Creek] at the north west end of the *sausal*."

During the summer months there would have been no surface connection between the two creeks. In winter, however, high flows through distributary channels and seasonal wetlands would have connected them. H.C. Malone (1858) noted that in the early 1850s "in dry weather the Penitencia [referring to Upper Penitencia] did not run through the *sausal* but in wet weather it did." Ygnacio Sibrian, in an 1858 deposition for the Milpitas land grant, further described the nature of the connection:

> Q. Did the waters of the Aguaje sink at in or near the *sausales* or do they form a continuous stream with the Penitencia?
>
> A. In the winter time the waters flowed over into the Penitencia.

These observations are supported by early maps of the creeks. Though coarsely drawn, many depict a connection between Upper and Lower Penitencia creeks (e.g., Lewis 1865, Healy 1866, Whitney 1873).

This bimodal nomenclature is not unique to Upper/Lower Penitencia Creek. It is associated with other systems in the Santa Clara Valley where, as in this case, an upper creek reach was seasonally connected to a lower creek reach through a complex of willow thickets, freshwater marsh, and sloughs and swales, though they did not share a continuous channel. In addition to Arroyo Aguaje/Penitencia Creek, this was the case for the Arroyo Seco de Guadalupe/Guadalupe River system in San José as well as for Saratoga Creek/Sanjon Creek in western Santa Clara Valley (see Beller et al. 2010).

The hydrologic connection between the two creeks appears to have engendered some nomenclatural confusion, and the seasonal flows described above may have been a key contributor to the early interchangeable use of both "Aguaje" and "Penitencia" for today's Upper Penitencia Creek. While Arroyo Aguaje was clearly viewed as the primary name for what is now Upper Penitencia Creek through at least the 1860s, the stream was also known by some as Penitencia Creek, even as early as 1854 (e.g., Day 1854, Pyle 1860, Lewis 1865). One 1858 observer stated that "I know the Coyote and all the streams in the neighborhood but can't say I know the Aguaje by that name. I know a stream sometimes called

Q. What part of this stream did you formerly know by the name of Aguaje and what part by the name of Penitencia?

A. As far as I know above the sausal it is called the Aguaje and below the sausal the Penitencia.

—JAMES MURPHY 1858

the Penitencia" (Malone 1858). Many surveyors and residents in the 1850s and 1860s referred to the creek using both names: "Aguage or Penitencia Creek" (Healy 1860; see also Quivvy 1858, Peck 1861, Geological Survey of California 1865, *Sacramento Daily Union* 1866, Whitney 1873). In 1861, surveyor Charles T. Healy was asked in court: "Are not the Arroyo del Aguaje and the Penitencia Creek the same stream, and only called by different names?" (Healy 1861b). He responded: "They may be so considered, tho, as I before stated, the channels are not continuous. I think they were not called the same stream, in former years."

By the 1870s, the use of the name "Penitencia" in place of "Aguaje" to refer to what is now Upper Penitencia Creek appeared more commonly in the historical record (e.g., Hare 1872, Thompson and West 1876, Ayer et al. ca. 1880, Coombe 1881, Herrmann 1884). However, even into the late 19th century some observers thought that the application of "Penitencia" to refer to Arroyo Aguaje was incorrect: Hall (1871) wrote of "the rivulet known as the Aguage, but erroneously called by some La Penitencia," and Shortridge ([1896]1986) described the "stream now known as La Penitencia," clarifying that "the true creek Penitencia, however, is the little stream which rises on the Murphy farm and flows north to Milpitas. The proper name of the Alum Rock Creek is Aguage."

It is worth noting that a few sources indicate that the downstream terminus of Upper Penitencia Creek was located further upstream than previously supposed. These sources indicate that the creek's defined channel may have ended as far east as near the downstream Mabury Road crossing, about one half mile upstream of the 110-degree turn in the creek that connects Upper Penitencia to Coyote Creek. Evidence includes an early map showing the creek entering the *sausal* at this upstream location (Day 1850) and mid-19th century testimony specifying distances between the termination of Upper Penitencia Creek and other natural features that are more consistent with the upstream location (Sibrian 1858, Tracy 1858). Though inconclusive, these data imply that some of the lowest reaches of Upper Penitencia Creek below the downstream Mabury Road crossing may be the result of early water engineering efforts in the valley, and are either artificially constructed channels or enlargements of former sloughs or small natural channels. It is also possible that these lowest reaches represent a natural downstream extension of the defined creek channel as a result of historical high flows.

PENITENCIA CREEK WETLAND COMPLEX

The presence of a large wetland complex separating Upper and Lower Penitencia creeks in the 19th century is well documented by historical sources. Early maps of the area depict a large wetland between the two creeks, variously shown with hatch marks notating a wetland (U.S. District Court 1840, Thompson et al. 1866), or with trees and labeled *sausal del pueblo* ("willow grove of the city of San José"; U.S. District Court 1839) or simply *sausales* (U.S. District Court ca. 1840a,b; fig. 3). Our historical mapping, synthesized from multiple historical documents, documents the

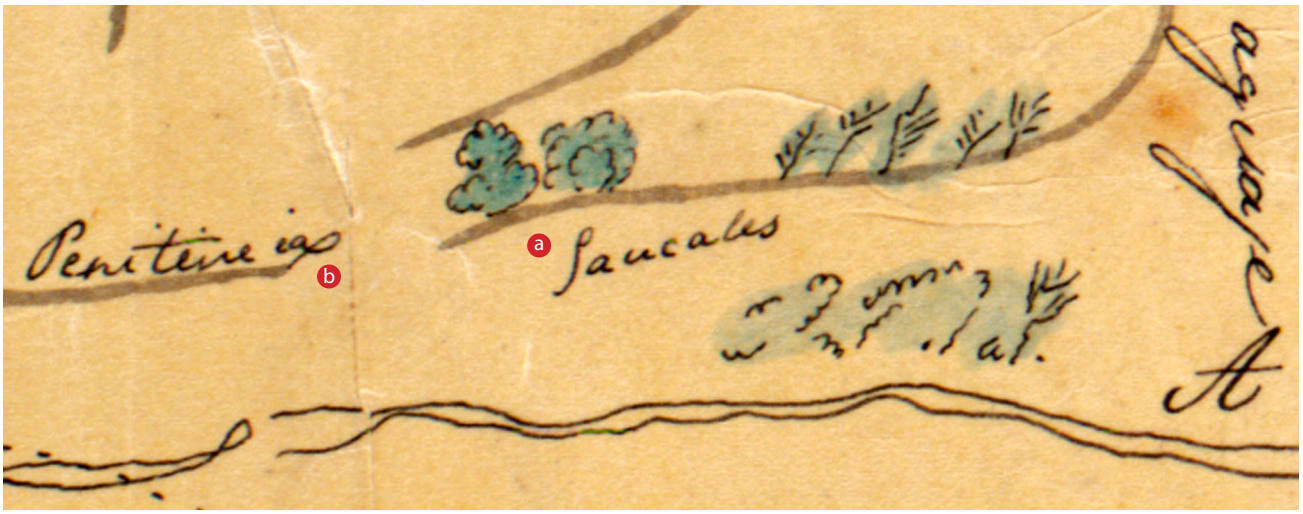

Fig. 3. Multiple willow groves, labeled *saucales* [sic], are shown in this early (ca. 1840) map at the mouth of Arroyo Aguaje (Upper Penitencia Creek) a. (Upper and Lower Penitencia creeks are represented as thick grey lines; the head of Lower Penitencia is labeled "Penitencia" b.) (U.S. District Court ca. 1840b, courtesy of The Bancroft Library, UC Berkeley)

presence of willow groves, seasonally flooded wetlands, and freshwater marsh between the termination of Upper Penitencia Creek and the higher ground of the Coyote Creek natural levee.

Narrative accounts also emphasize the presence of an extensive wetland complex, including thickets of willows, at the spread of Upper Penitencia Creek. The creek was observed to spread in an extensive willow thicket, covering at least 45 acres (Day 1850), east of Coyote Creek's natural levee. Local property owner James Murphy (1858) described that Arroyo Aguaje "runs into the *sausal* and forms a kind of swamp in wet weather…between the Coyote bank and the willows, and in the willows."

Local residents called the grove the *Montecito Alto* (upper little thicket), the *Sausal Grande* (large willow grove), or simply the *sausal* (Bernal 1858, Tracy 1858, Alviso 1861a, Denamell 1861). Surveyor Healy (1861b) explained that Upper Penitencia Creek "spreads in a large willow swamp along the bank of the Coyote… These willows or a portion of them have been called the *Monticito Alto*, the Penetencia Creek which empties into the bay of San Francisco has its source in the swamp referred to" (fig. 4). Surveyor Sherman Day also noted the "willows…in swamp" in the area where Upper Penitencia Creek ended (Day 1854).

In addition to the large willow thicket described at the immediate terminus of Upper Penitencia Creek, numerous other, smaller willow groves were also described to the northwest. Ygnacio Sibrian (1858), in describing the *sausales* found in the area, clarified that he used the term *sausales* (plural of *sausal*) "because there is more than one." Early maps of the region depicted multiple, discrete groves; one map distinguishes between a grove of willows (*sausal*) at the immediate terminus of Upper Penitencia Creek and a grove of willows and cottonwoods (*sausal, alamos*) immediately to the north (Sibrian ca. 1858; fig. 5). Another willow grove called the *montecito* ("little thicket," despite covering around forty acres) was found to the north of the willow thicket at the sink of Upper Penitencia Creek, in the vicinity of present-day Ringwood Avenue and Concourse Drive. (Presumably this was

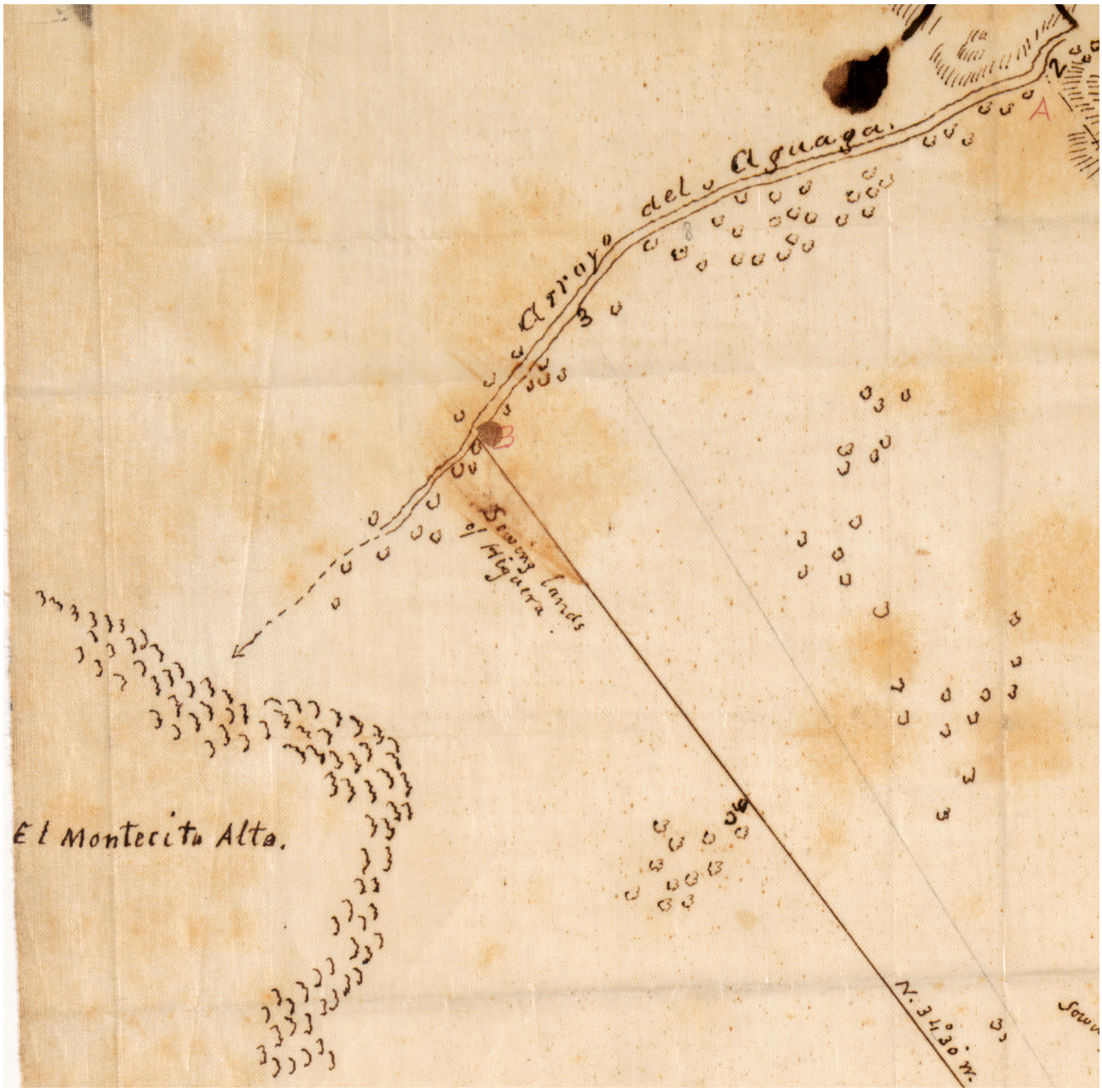

Fig. 4. Surveyor Charles T. Healy's depiction of a portion of the Montecito Alto at the terminus of Upper Penitenicia Creek, here labeled "Arroyo del Aguaga." (Healy 1861a, courtesy of The Bancroft Library, UC Berkeley)

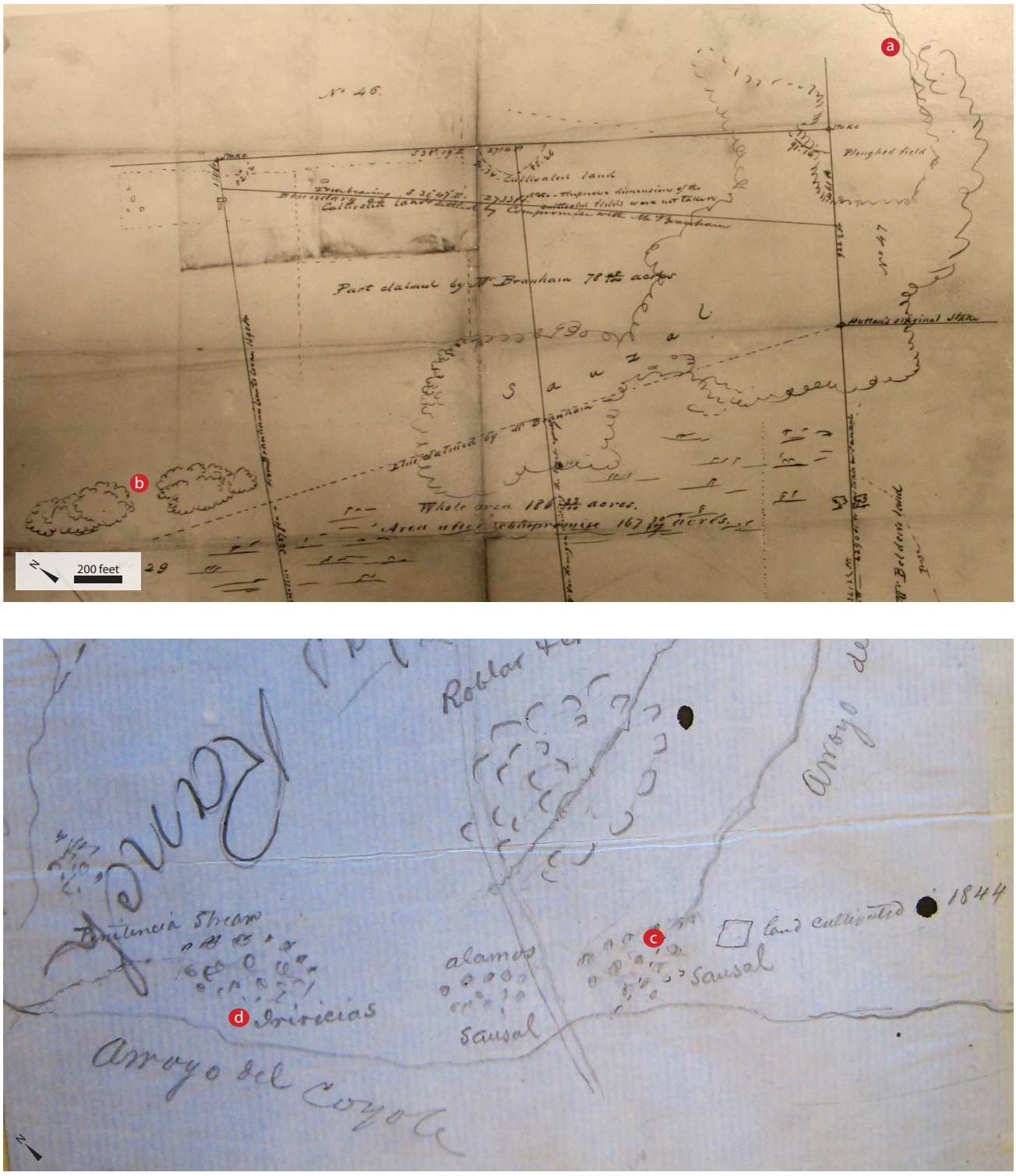

Fig. 5. These two early maps, both dating from the 1850s, indicate the presence of multiple willow thickets in the vicinity of the mouth of Upper Penitencia Creek and the head of Lower Penitencia Creek. Surveyor Sherman Day (top) shows Upper Penitencia Creek (a) discharging into a large "sauzal," surrounded by a strip of freshwater marsh and smaller willow groves to the north (b). A sketch by Ygnacio Sibrian (bottom) also shows multiple willow groves east of Coyote Creek and stretching north from the mouth of Upper Penitencia Creek (c). This includes the grove labeled "Iriricias" (d), here shown to be the head of (Lower) Penitencia Creek, labeled "Penitencia Stream" on the map. (Day 1850, courtesy of the Office of the Santa Clara County Surveyor; Sibrian ca. 1858, courtesy of The Bancroft Library, UC Berkeley)

the "lower little thicket," in comparison to the upper *Montecito Alto* mentioned above.) This willow thicket served to mark the southern boundary of Rancho Milpitas.

There is a grove of trees called "Las Iririses"…

—ALVISO 1861B

Yet another willow grove was documented in the vicinity of the *montecito*, a thicket of willows called the Iririses or Idirisias by early residents (cf. Sibrian 1858, Alviso 1861b). (The origin and meaning of the name are unknown.) This grove was part of the same line of willow thickets running northwestwardly along the base of the alluvial fans of Upper Penitencia and Berryessa creeks. Though its exact location and extent are ambiguous, it was described as east of Lower Penitencia Creek, and appears to have been potentially associated with both the Upper/Lower Penitencia Creek systems as well as with what is now known as Berryessa Creek. Early sources suggest that Lower Penitencia Creek may have at least partially run through the Idirisias grove:

> In the summer time the waters of the Aguaje…disappeared and then appeared again on the source of the Penitencia and on the end of the Idirisias. (Sibrian 1858)

It is unclear whether the above quotation implies two reappearances of water from Upper Penitencia Creek/Arroyo Aguaje (that is, one at the source of Lower Penitencia Creek and another in the Idirisias willow thicket) or whether it implies that the source of Lower Penitencia Creek was found in the Idirisias.

Landowner Nicolas Berryessa (also spelled Berreyesa) used these moist willow groves to pasture his stock: "in the summer time when it was dry he [Berryessa] had his cattle and animals in the low land in the Idirisias the *sausales* and the part or side of the Coyote" (Sibrian 1858). The *sausal* and Idirisias were also used as woodlots, though "no one could enter to cut wood without permission of Berryessa."

The precise spatial relationship between each of these willow groves is not well documented. It has been suggested that descriptions of willow thickets from the 1850s and 1860s underestimate the earlier extent of these groves, which may have been far more extensive in this area prior to clearing and grazing activities of the early 1800s. Brown (2005) suggests that in fact many of these groves may have been connected historically, forming a more continuous belt of willows and wetlands east of Coyote Creek and between Upper Penitencia Creek, Lower Penitenicia Creek, and Berryessa Creek. While we found no explicit evidence to support this, it is consistent with the dramatic, early loss of willow groves documented across other portions of Santa Clara Valley from woodcutting, clearing, and grazing, particularly in areas near pueblo San José and the Santa Clara Mission (see Beller et al. 2010).

Though the timing of these groves' disappearance is also poorly documented, certainly by the 1870s large areas of this marsh and willow complex had been drained and cleared. A county property map from

1876 shows a small (about 20 acre) remnant wetland at the head of Lower Penitencia Creek (near what is now Townsend Avenue; Thompson and West 1876). A contemporary account confirmed that Upper Penitencia Creek still terminated in a willow grove during this time, though with apparently much reduced area:

> The rivulet known as the Aguage, but erroneously called by some La Penitencia… loses itself in the low ground and in the rainy seasons floods the land on which stands the patch of willows near the premises of James Murphy, and whence springs the little stream, the true appellation of which is La Penitencia (Penitence). (Hall 1871)

The diversion of flows from Upper Penitencia Creek into Coyote Creek in the early 1850s (see section below) likely also altered the hydrology of the willow groves, possibly contributing to their eventual demise. No map dating from after 1890 was found showing any remnant of the former willow grove immediately at the mouth of Upper Penitencia Creek, suggesting the relatively early elimination of the feature (e.g., see Herrmann Bros. 1890, USGS 1899, Herrmann 1905). We were unable to find any maps showing the area during the 1880s.

ORIGIN OF THE UPPER PENITENCIA-COYOTE CREEK CONNECTION

Through the first half of the 19th century, water from Upper Penitencia Creek (then known as Arroyo Aguaje) primarily made its way to the San Francisco Bay through the marsh and willow complex and Lower Penitencia Creek as described above, running roughly parallel to the much larger Coyote Creek mainstem. In the early 1850s, however, a modification was made to Upper Penitencia Creek that dramatically altered its hydrology. Around 1851, a local landowner dug a ditch from the termination of Upper Penitencia Creek through the willow grove to Coyote Creek. The ditch was dug along a half mile stretch just to the south of (and paralleling) Berryessa Road, and is the origin of the distinctly unnatural 110-degree turn Upper Penitencia Creek takes on its way to Coyote Creek.

A. In the year [18]52 or 53, I forget which, a Frenchman had dug a ditch along the road and a heavy freshet came through that ditch the Aguaje washed into the Coyote – washed a deep ravine.

Q. Prior to the time you speak of did or did not the Aguaje join the Coyote at any place?

A. Not that I know of.

—F.P. TRACY 1858

The purpose of this new drainage was apparently to reduce wintertime flooding at the mouth of the creek, but it had the added effect of connecting Upper Penitencia Creek to Coyote Creek for the first time (Arbuckle 1986). The new connection was likely reinforced during the winter of 1852-1853, when flood flows from Upper Penitencia Creek breached Coyote Creek's natural levee and created a permanent connection between the two creeks. (The winter of 1852-53 was one of high rainfall in the region; data for rainfall analysis courtesy of Jan Null.)

While many historical attributes of Upper Penitencia Creek are poorly documented, this modification is thoroughly described by historical documents. The reason is that the origin of the connection was an important piece of evidence upon which the court case testimony over the Milpitas land grant hinged (*United States vs. Nicolás Berreyesa*). In the case, Berreyesa filed a claim to the Milpitas Rancho, which he declared was

bounded on the south by Upper Penitencia (Aguaje) Creek. He presented evidence of his entitlement to the property in the form of a sketched map, or *diseño*, which he claimed dated from 1835 and which depicted a direct connection between Upper Penitencia Creek and the Coyote Creek. Testimonies against Berreyesa as recorded in the court case sought to establish that since the connection did not exist until the early 1850s, far after the purported date of the map, the map was fraudulent (see Sawyer 1922).

As a result, the court case is full of early testimony describing the origin of this diversion by those familiar with the region and the creek. Witnesses uniformly described the creation of a ditch in the early 1850s joining the previously unconnected Upper Penitencia and Coyote creeks: "the water [from Upper Penitencia] comes from the Monte [willow thicket at the mouth of the creek] and enters a ditch and from the ditch it enters into the Coyote" (Bernal 1858); "there was a ditch dug…to let the water run into the Coyote" (Murphy 1858); "a deep cut in the Eastern bank of the Coyote which, in the wet season, drains the swamp + willows before alluded to" (Healy 1861b). Deponents even recalled the nationality ("a Frenchman"; Tracy 1858) and the name ("the man who I saw dig it was Harden"; Murphy 1858) of the ditch digger.

Though the derivation and timing of the Coyote Creek connection is abundantly documented, its effects on Upper Penitencia Creek's hydrology are more ambiguous. In particular, accounts provide conflicting reports on how the Upper-Lower Penitencia Creek connection was affected by the ditch. One resident reported that upon completion of the ditch, Upper and Lower Penitencia Creek had "become as two streams now"; that is, that all of the flow from Upper Penitencia Creek was diverted through the ditch into Coyote Creek (Goodrich 1858). However, another stated that with the completion of the ditch Upper Penitencia Creek had two outlets from the willow grove, one through the ditch to Coyote Creek and the other through Lower Penitencia Creek. H.C. Malone described that "the Penitencia or a great portion of it now empties into the Coyote":

> Q. Are there now two continuous channel ways from the sausal including the ditch?
>
> A. There is. (Malone 1858)

Maps depicting the creek in the second half of the 19th century largely support the existence of some form of connection between Upper and Lower Penitencia creeks (e.g., Lewis 1865, Healy 1866, Hare 1872, Whitney 1873). This interpretation is consistent with earlier descriptions of the two creeks' indirect connection, which would have been unlikely to have been immediately and completely erased by the Upper Penitenicia-Coyote Creek ditch diversion. These maps also imply that the connection between Upper and Lower Penitencia creeks may have been made even more persistent during the mid-1800s, perhaps through the enlargement of natural sloughs or the creation of artificial ditches connecting the two creeks. This more

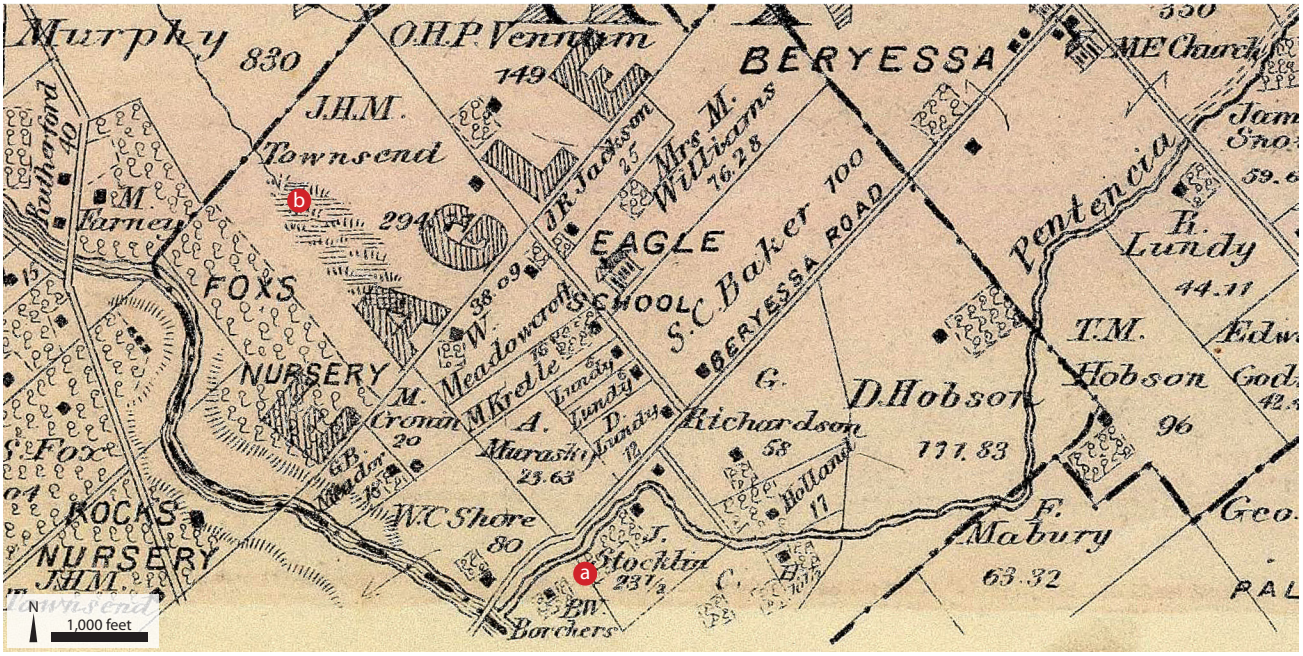

Fig. 6. An early rendering of Upper and Lower Penitencia creeks after the creation of a connection between Upper Penitencia and Coyote Creek. The map shows Upper Penitencia Creek following essentially the same course it does today, with the sharp left turn following Berryessa Road and emptying into Coyote Creek a. Lower Penitencia Creek is shown disconnected from the upper stream, originating in a marsh b less than a mile away. (Thompson and West 1876, courtesy of David Rumsey Map Collection)

established connection may have resulted in the permanent extension of the "Penitencia" name to the entire system, before the creeks' full disconnection during the later 19th century as the Coyote Creek-Upper Penitencia Creek connection became the sole flow pathway.

However, many of these maps show relatively coarse depictions of the creek; many do not even depict the connection between Upper Penitencia and Coyote creeks. A more detailed early map of the creek shows the artificial connection between Upper Penitencia and Coyote, with the head of Lower Penitencia Creek a little less than a mile away (Thompson and West 1876; fig. 6).

By the late 19th and early 20th centuries, Upper and Lower Penitencia creeks were consistently shown as disconnected streams (e.g., Herrmann Bros. 1890, USGS 1899, Herrmann 1905). It is not clear whether this is a result of a shift in the system's hydrologic connectivity (for example, as willow groves were cleared and wetlands and sloughs drained) or simply a result of more accurate mapping. Additional local data may clarify the timing of when the Coyote Creek ditch became the primary flow pathway for water from Upper Penitencia Creek, as well as the nature of the Upper-Lower Penitencia Creek connection as it existed in the mid-19th century.

Channel Alignment

Upper Penitencia Creek currently flows predominantly in a single-thread channel from the hills downstream to its confluence with Coyote Creek. Today's channel is relatively straight, with a few gentle meanders and relatively low overall sinuosity on the valley floor.

Despite extensive modifications to the creek in the historical period, comparison of historical channel position (as shown on survey maps) and

Fig. 7. Planform of Upper Penitencia Creek from the hills westward to near Capitol Avenue. Despite major modifications to the creek and surrounding landscape over the past 120 years, the general alignment of the creek has not changed substantially since the 1880s in this section. (Ayer et al. ca. 1880, courtesy of the Office of the Santa Clara County Surveyor; USDA 1939; USDA 2009)

the modern creek alignment above the former distributary reveal few significant differences. Above its historical distributary in the vicinity of King Road/downstream Mabury Road crossing, Upper Penitencia Creek's channel location exhibits notable persistence in most places from the mid- to late-19th century to the early 21st century (fig. 7). The creek was used as the northern boundary for the Pala rancho, and the early U.S. survey of the rancho (though coarse) shows the creek as quite straight (Wallace 1858b). Subsequent, more detailed maps of portions of the creek also

support the absence of substantial meanders, and in most cases mirror the creek's modern alignment (e.g., Bowen 1865, Ayer et al. ca. 1880, Herrmann 1884, McMillan 1891). This is in contrast to other rivers and creeks in the region which have been heavily straightened, resulting in the considerable loss of meanders (e.g., Lower Penitencia Creek, Guadalupe River).

Limited shifts in channel alignment can be identified in a few areas, however. The most substantial documented change occurred relatively recently, in the vicinity of the Interstate 680 crossing (fig. 8). A short section of the channel was moved approximately 200 feet north into a new, straighter channel, a realignment that took place during the construction of I-680 in the early 1970s (Coombe 1881, DeJager and Martel 2006; fig. 9). In addition, historical sources show a few instances where former side channels have been eliminated, for example from the canyon mouth downstream to Noble Avenue, and just downstream of I-680 (Coombe 1881, Herrmann 1902; fig. 10). There are almost certainly additional side channels that have been removed from the system but remain undocumented by the historical maps uncovered through our research.

Fig. 8. Old channel of Upper Penitencia Creek west of Interstate 680, November 2011. This is the meander depicted in figure 9, which is now disconnected from the stream course.

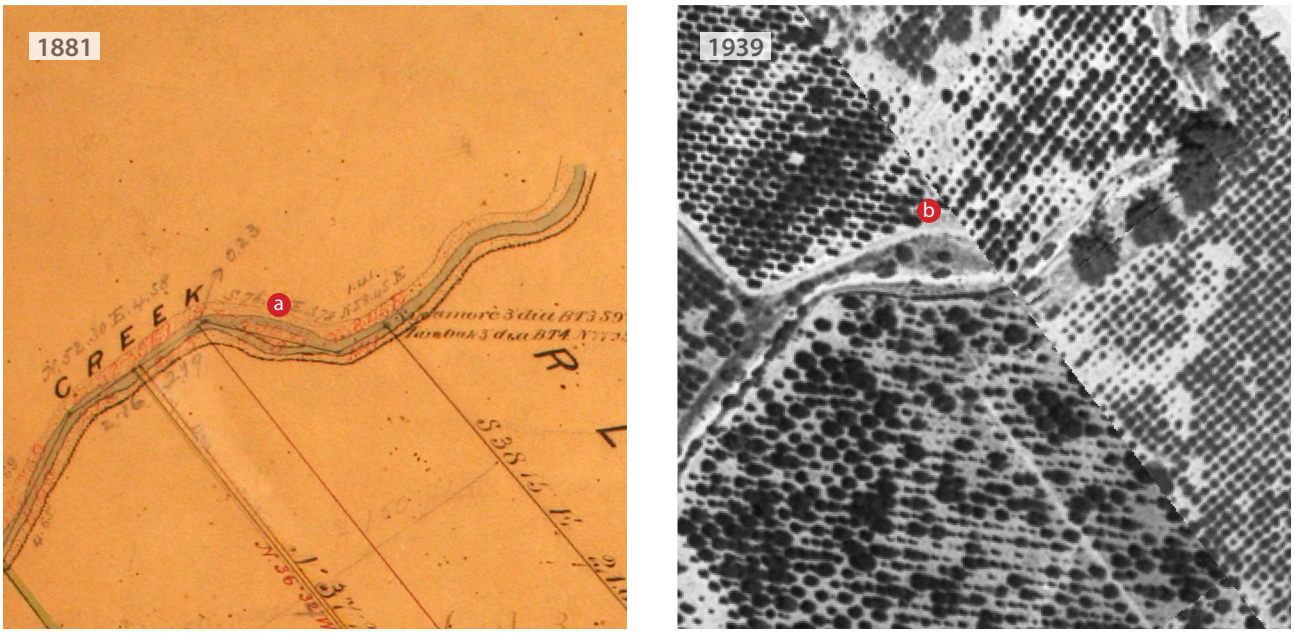

Fig. 9. A meander documented in 1881 a, still visible on the 1939 aerial b, has been removed by 2009. (Coombe 1881, courtesy of the Office of the Santa Clara County Surveyor; USDA 1939; USDA 2009)

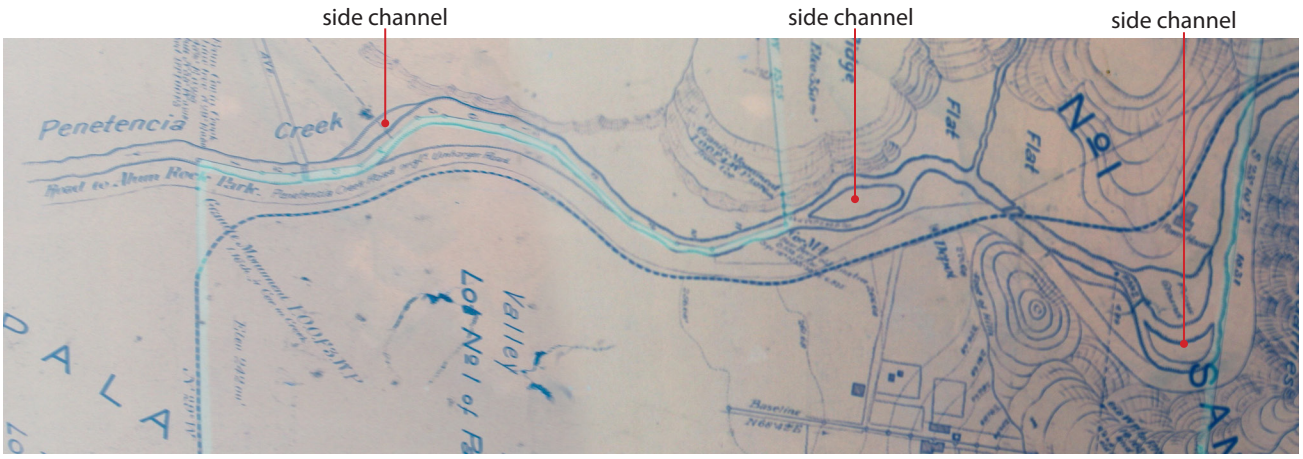

Fig. 10. Multiple side channels are shown along the creek from the canyon mouth to Noble Avenue in this 1902 map. (Herrmann 1902, courtesy of the Santa Clara County Clerk-Recorder)

There are a few additional small discrepancies between the creek alignment as seen today and as depicted by historical sources. However, some of these subtle differences may be a byproduct of the map georeferencing process rather than a true change in creek location. This is the case for a half mile reach upstream of the upstream Mabury Road crossing, where the 1939 aerial photography appears to show the channel slightly (<75 feet) to the east of its current location (USDA 1939). It is also evident near Piedmont Road, where a gentle bend in the creek apparent on a historical map appears somewhat truncated today (Ayer et al. ca. 1880, USDA 2009).

In conclusion, with few exceptions no major loss of sizeable meanders on Upper Penitencia Creek is apparent over the past 130 years. An overall persistence in planform is observed in comparisons of historical and contemporary sources. However, early modifications to channel location, predating detailed survey maps, are possible – even likely – as are changes not documented by any surviving historical source. Some fine-scale changes to creek alignment may not have been identified through this analysis as a result of the coarse scale and limited accuracy of historical maps. These potential additional changes to creek alignment may have resulted in a reduction in channel complexity (e.g., side channels, bars, and islands) or sinuosity (through channel straightening and truncation of small meanders).

Dry Season Hydrology

Extending through the tract lengthwise a distance of several miles is the beautiful mountain stream now known as La Penitencia. It rises well up towards the summit of the mountains, and is augmented by water from springs and brooks flowing into it until it becomes a good sized stream. It goes rushing through a rough canyon, over rocky rapids, and through narrow gorges, and deep pools.

—SHORTRIDGE [1896]1986

A number of hydromodifications have impacted the dry season hydrology of the creek. Releases from Cherry Flat Dam (constructed in the upper watershed in 1936), the Santa Clara Valley Water District's off-channel percolation ponds, and imported water from the South Bay Aqueduct have all affected dry season flow patterns (DeJager and Martel 2006, Stillwater Sciences 2006). Unfortunately, there is limited explicit documentation of historical summer and fall flow conditions on Upper Penitencia Creek. However, several historical documents provide sufficient information to suggest general trends in flow along the creek.

Flow in the canyon reaches of Upper Penitencia Creek is primarily derived from springs and its main perennial tributary, Arroyo Aguague (Sillwater Sciences 2006). Historical perennial flow conditions in this section of Upper Penitencia Creek are well documented. A hugely popular picnicking and outing spot, Alum Rock Park inspired many dramatic descriptions of the creek and its surroundings. A 1916 plan for the conservation and development of Alum Rock Park described the creek as a "winding, very beautiful mountain stream…with its constant and at times torrential flow of water" (Child 1916), consistent with an account from fifty years earlier that stated that the creek "is never-failing in the hills" (*Sacramento Daily Union* 1866). A General Land Office surveyor, crossing the creek about a mile and a half up the canyon in mid-July 1854, also noted "water 12 links [8 feet] wide" flowing in the creek (Day 1854). Early (1899) U.S. Geological Survey

mapping of the area shows the creek as a solid blue line through the canyon, a convention usually used by USGS mappers to signify a perennial stream with regular, year-round flow (USGS 1913).

On entering the canyon, I crossed a fine stream of running water, containing mountain trout. The first object of real interest that meets the eye is Alum Rock, about a mile and a half from the entrance of the canyon….It is a romantic scene, just such a place that would suit the tourist and those who love wild and rugged scenery. A mile above, I came to a small but beautiful waterfall, and in the deep water below we saw numerous trout and other fish.

—*SACRAMENTO DAILY UNION* 1862, DESCRIBING A TRIP TAKEN IN MID-JUNE 1862

As small creeks descended westward into the Santa Clara Valley from the Diablo Range, many – if not most – lost surface flow in the dry season soon after exiting the hills. Perennial flow in the canyon reaches sank into the coarse alluvial fan deposits of the valley floor, recharging groundwater aquifers and creating creek beds with no summertime surface flow. Even Coyote Creek had an intermittent hydrology (with subsurface flow) for most of its course along the Santa Clara Valley floor (Grossinger et al. 2006). This trend is supported by general accounts of summer flow patterns in Santa Clara Valley creeks by early observers:

> …the dry beds of what, in the wet season, are running streams… (Revere 1849)

> When the long, dry, summer days come on, they fail almost entirely, disappearing in places for miles, then perhaps running fresh and clear, though in small volume, for a short distance over a rocky bed, only to sink from sight again, possibly not to reappear again through all the course of the stream to its outlet in river, sea, or bay. (Evans 1873)

> Only two of these streams, the Guadalupe and Coyote creeks, are perennial, and in these there is but little surface flow during the dry season…Other streams of the area are dry throughout their courses across the valley during the summer months. (Lapham 1904)

> On the approach of the dry season all the streams of the region rapidly shrink, both in volume and length. (Snyder 1905)

General descriptions of Upper Penitencia Creek also emphasize its intermittent hydrology, naming it as one of the creeks that "flow into the valley at different points, their waters sinking into the gravel as they reach the plain" (*San Jose Mercury* 1872) and one of the "chief intermittent creeks" of the Santa Clara Valley (Boone 1922). It was observed that "in dry weather the [Upper] Penitencia did not run through the *sausal*, but in wet weather it did" (Malone 1858), suggesting that summer flow ceased before the termination of the creek. Even Lower Penitencia Creek, originating in the wetlands and willow thickets at the base of Upper Penitencia Creek, was noted to be dry in late October 1841 a few miles north of its source (Eld 1841).

These descriptions are supported by the abundance of sycamore trees noted by 19th century surveyors along Upper Penitencia Creek upstream of Capitol Avenue (see riparian vegetation section, page 23). The historical presence – possibly even dominance – of sycamores along the creek in this reach is compelling evidence in support of former intermittent conditions, since sycamores are strongly favored by dry season conditions in reaches with coarse substrates and summer access to groundwater (Keeler-Wolf et al. 1996, DeJager and Martel 2006). These descriptions suggest that Upper

Penitencia Creek was likely intermittent for much, if not all, of its course on the valley floor.

However, a few pieces of evidence provide conflicting accounts of the stream's dry season hydrology on its alluvial fan. One early account specified that while the creek was connected through surface flows to Lower Penitencia Creek in the winter, "in the summer time the waters of the Aguaje [Upper Penitencia] came down some two miles below the hills and then disappeared" (Sibrian 1858). Two miles below the hills is roughly at the Capitol Avenue crossing, representing a substantial portion of the upper creek on the valley floor. This account suggests that low levels of summer baseflow may have persisted across substantial portions of the valley floor well into the dry season (in response to wet years or late season precipitation).

The earliest topographic quadrangle for the creek (USGS 1899) also shows it as a solid blue line, indicating perennial flow (USGS 1913). USGS flow mapping is often quite accurate (e.g., see Beller et al. 2011), and it is possible that this mapping reflects very limited summer surface flow on the plain during some years. However, USGS mapping is also coarse, and on this particular quadrangle it does not correctly reflect creek reaches clearly demonstrated to be intermittent by other historical ecology projects (e.g., Coyote Creek and upper Guadalupe River; see Grossinger et al. 2006, Beller et al. 2010). Given these caveats, the interpretation of dry season hydrology from this map is not definitive.

Santa Clara is the only county of the San Francisco bay division in which irrigation is practiced to any considerable extent. The water taken from streams, which is supplied principally by Penitencia Creek, is used chiefly for orchards, and is applied during the winter season, two or three applications generally being sufficient.

—*Pacific Rural Press* 1902

Winter and spring surface flow from Upper Penitencia Creek was used beginning at least in the mid-1800s to irrigate adjacent farmlands (see quote at left). Evidence documenting use of Upper Penitencia Creek for irrigation dates to the early 1860s, when a newspaper article from winter 1861 reported that the creek ran through its narrow canyon

> until its waters finally glide noiselessly into the level valley below, where it is turned off to perform the many services it bestows on the inhabitants of the plain, to supply the kitchen, and to irrigate the garden and orchard. (*Daily Alta California* 1861)

Descriptions of farms bordering Upper Penitencia Creek in the 1880s also noted the use of surface diversions to irrigate the prune, peach, apricot, and plum orchards prevalent in that section of the valley. A farm north of the creek and west of Piedmont Road was described as "so situated that it can be irrigated from the Penitencia Creek during the rainy season," as was another property about a half mile downstream (east of Capitol Avenue) "irrigated by water from the Penitencia Creek" (Foote 1888; fig. 11). A 1921 report on water in the valley noted "several small dams" along the creek diverting water to adjoining farms (Tibbetts and Kieffer 1921). Diversions appear to have principally occurred during the wet season, mitigating their effect on dry season flow. However, the extent of the impact of these diversions on flow conditions is unknown.

Fig. 11. Ditch on the Shaw property, 1884. Landowners adjacent to Upper Penitencia Creek used wet season flows for irrigation, as shown here by a ditch diverting water to the Shaw property a. (Herrmann 1884, courtesy of the Office of the Santa Clara County Surveyor)

Riparian Vegetation

Extensive modifications to Upper Penitencia Creek over the past 250 years, including the creation of a connection to Coyote Creek and alterations of its hydrology, have been documented above. Similar questions arise regarding the historical character, distribution, and extent of riparian plant species along the creek prior to these and other changes. Luckily, considerable evidence captured in early sources is available to inform our understanding of the creek's former riparian vegetation.

The first two miles of the Upper Penitencia Creek canyon historically supported a mixed riparian corridor, with documented sycamores, live oaks, madrone, California bay, alders, maples, willows, and other trees typical of a narrow canyon with year-round flow (fig. 12). Early twentieth century accounts described "spreading oaks, alders, maples and sycamores through which the creek makes its rippling way" (Child 1916), and the creek "lined with sycamore, madrona, laurel and oak trees" (Drury and Drury 1913).

Landscape architect Stephen Child, hired by the city of San José in the early twentieth century to create a plan for the continued development of Alum Rock Park, included a proposal for restoration in the park and along the creek (Child 1916; see also Scott 1985). He argued that native plants "will always be found to harmonize and in the end satisfy by their natural beauty far better than any exotics," and provided a list of native trees appropriate

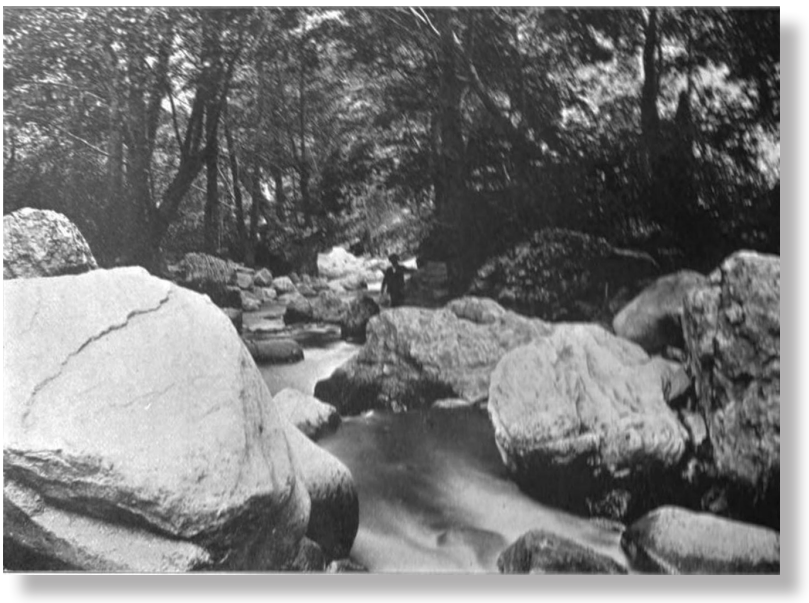

Fig. 12. Two early views of Upper Penitencia Creek in Alum Rock Park, both taken around the turn of the 20th century, emphasize the rocks and boulders of the creek bed, as well as the dense, continuous riparian corridor along the creek. (Top: Unknown ca. 1900b, courtesy of the California Room, San Jose Public Library; bottom: Unknown ca. 1900a)

for riparian restoration along the creek. The list included sycamore, black willow, big leaf maple, alder, buckeye, elderberry, "all native oaks," and California bay, in addition to an assortment of shrubs and vines.

Nineteenth century records of lower canyon riparian vegetation are consistent with these descriptions. The earliest account found of riparian cover in the canyon dates from mid-July 1854, from a government survey which crossed the creek about a mile and a half up the canyon. The surveyor noted a "narrow strip of bottom land among bushes and timber" and the creek's "rocky bed, shaded with trees and bushes" (Day 1854). He also noted two sycamores (20" and 14" in diameter) and one willow (12" diameter) in the vicinity. (Other surveys in this portion of the canyon also note riparian trees, including two 17" and 18" diameter sycamores; Wallace 1858a, Herrmann 1883). An 1861 description of the creek near the same area described a similar scene of riparian trees and understory:

> From this place you may follow the course of the Penitentia with your eye, as it flows on through the many windings of its rocky bed, beneath the shade formed by the dense foliage of tall and wide-spread evergreen oak and sycamore trees, with here and there a shrubby choke-cherry bush, heavily laden with its bunches of red berries… (*Daily Alta California* 1861)

As the creek exited the canyon onto the valley floor, the character of its riparian corridor shifted dramatically, from mixed riparian forest to a likely sparser, sycamore-dominated riparian canopy. One of the earliest depictions of the creek, included in a map of lands belonging to the city of San José, denoted the riparian corridor of Upper Penitencia Creek with an "A", which the map legend notes signifies *alisal*, or sycamore grove (U.S. District Court ca. 1840a,b; fig. 13). (Though *aliso* literally means "alder," in Spanish California the term was universally used to refer to sycamores.) The "A" designation is also used on the map to represent the Coyote Creek riparian corridor, which has been demonstrated to be historically characterized by sycamore-alluvial woodland (Grossinger et al. 2006). (This stands in contrast to riparian forest along the perennial lower Guadalupe River, denoted on the map with an "M" for *montes* (willow thickets), a designation also substantiated by historical research on that system; see Beller et al. 2010).

This early, generalized representation of the Upper Penitencia Creek riparian forest indicates the dominance of sycamores along the creek, an interpretation fully supported by subsequent historical sources. Eight historical survey maps, ranging from 1865 to 1891, provide continuous coverage of the creek from the canyon mouth to about 1,000 feet north of the upstream Mabury Road crossing, about three miles of the creek (Bowen 1865, Ayer et al. ca. 1880, Coombe 1881, Herrmann 1881, Herrmann 1884, Herrmann Bros. 1885, Herrmann Bros. 1895, McMillan 1891). The maps include information on riparian cover in the form of trees along the creek whose locations were used to complete the surveys (fig. 14).

"We came here first in January. You might easily imagine what that means to me just from New England. On the way out we were caught in a snow blockade but finally reached this paradise. … As soon as we were rested we went to Alum Rock. I think it was on the fifteenth, and here are the fruits of that trip." And she proudly pointed to a page on which were grouped bird-foot fern, beautiful gold-backed ferns, tender fronds of the Adiantum, and a perfect red trillium, and a dandelion.

—MISS ROSE, IN CARROLL 1903

Q. Have not all the arroyos, or nearly all to which you have referred, sycamore trees on or near their banks?

A. I am not certain about the one to the extreme south. The others have. I have noticed in riding through there that most of the streams have sycamores along them.

—PYLE 1860, SPEAKING OF VALLEY STREAMS ON THE PALA LAND GRANT

Fig. 13. This early map shows variation in riparian corridor on northeastern Santa Clara Valley streams, ca. 1840. Riparian designations are shown with a capital "A" signifying *alisal* or sycamores, or a capital "M" signifying *montes* or willow thickets. Upper Penitencia Creek (here labeled "Arrollo del Aguaje") and Coyote Creek are labeled "A" a, in contrast to lower Guadalupe River, labeled "M" b. (U.S. District Court ca. 1840b, courtesy of The Bancroft Library, UC Berkeley)

In all, these eight maps contain records of 41 trees from Upper Penitencia Creek's riparian corridor. (Every effort was made to not double count trees, comparing position and size carefully across maps.) Of these trees, 78% (32 trees) were sycamores (fig. 15). Sycamores were documented along nearly the entire length of the creek covered by these historical maps; the westernmost sycamore was recorded just west of what is now the Interstate 680 crossing.

Documented sycamores ranged in size from 4-inch diameter trees to a 70-inch diameter tree about 1/3 mile upstream from the Capitol Avenue crossing, with an average diameter of just over 18 inches (fig. 16). At least one sycamore sapling (4" diameter) was recorded a few hundred feet upstream of the Penitencia Creek Road crossing (Herrmann 1884). In total nine sycamores 8" in diameter or smaller were recorded; these relatively young trees suggest active recruitment during this period.

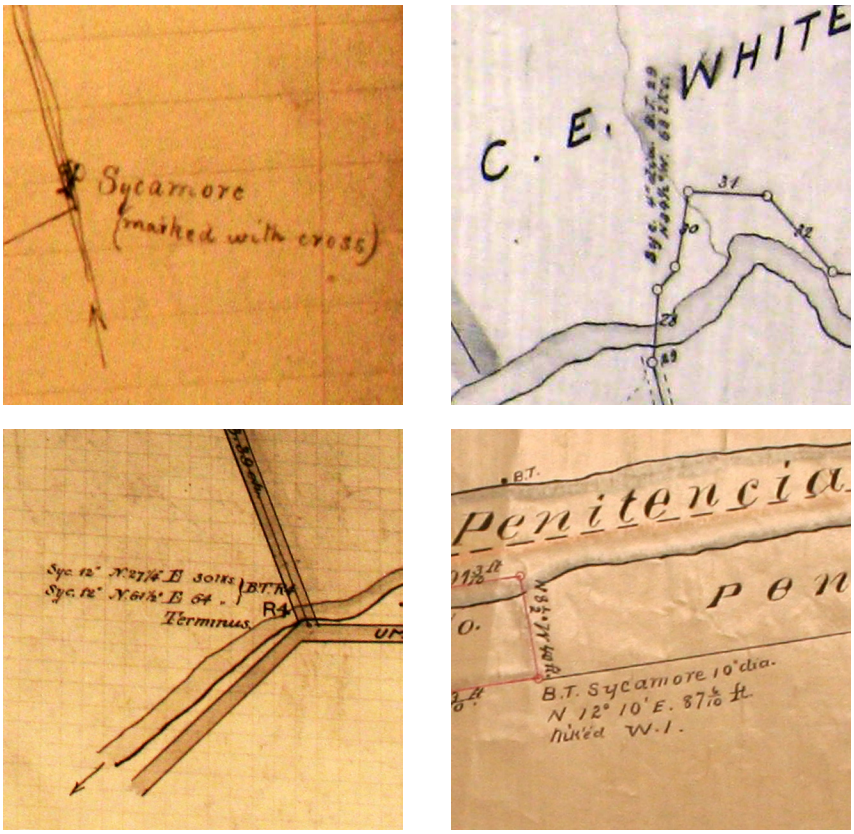

Fig. 14. Examples of sycamores used as bearing trees from 19th century survey maps. (Clockwise from top left: Bowen 1865, Herrmann 1884, Herrmann 1885, and McMillan 1891, courtesy of the Office of the Santa Clara County Surveyor)

A few other trees were also recorded by these surveys, including four large live oaks and two valley oaks (ranging in size from 20" to 48" in diameter; average size 39" in diameter), one California bay tree, a non-native eucalyptus, and a large tree recorded as a "locust." This is consistent with early qualitative descriptions of larger oak trees along this reach of the creek: "there was some oak trees called in Spanish Encinos [live oaks]… on the edge of the Arroyo" (Alviso 1861a; see also Henning 1860). Agustín Alviso was asked to describe the trees used for the survey of Pala Rancho's northern boundary in 1835:

> Q. What kind of trees were those you say you measured to in 1835, going down the Arroyo del Aguague?
>
> A. They were Encinos [live oaks] and Alisos [sycamores].
>
> Q. Are you sure they were not Robles [valley oaks]?
>
> A. Yes sir. (Alviso 1861a)

In contrast, no willows, cottonwoods, alders, or other more mesophytic species were documented along this three mile section of the creek. This is not necessarily proof of these species' absence, since sycamores and oaks would have likely been preferentially used as survey markers over these more short-lived trees (White 1983). However, on Llagas Creek in southern Santa Clara County, sycamores were also used as the primary survey tree along an intermittent reach while willows and cottonwoods (more hydrophilic species) were used in a perennial reach downstream, suggesting that these trees were used in certain situations (Grossinger et al. 2008). The

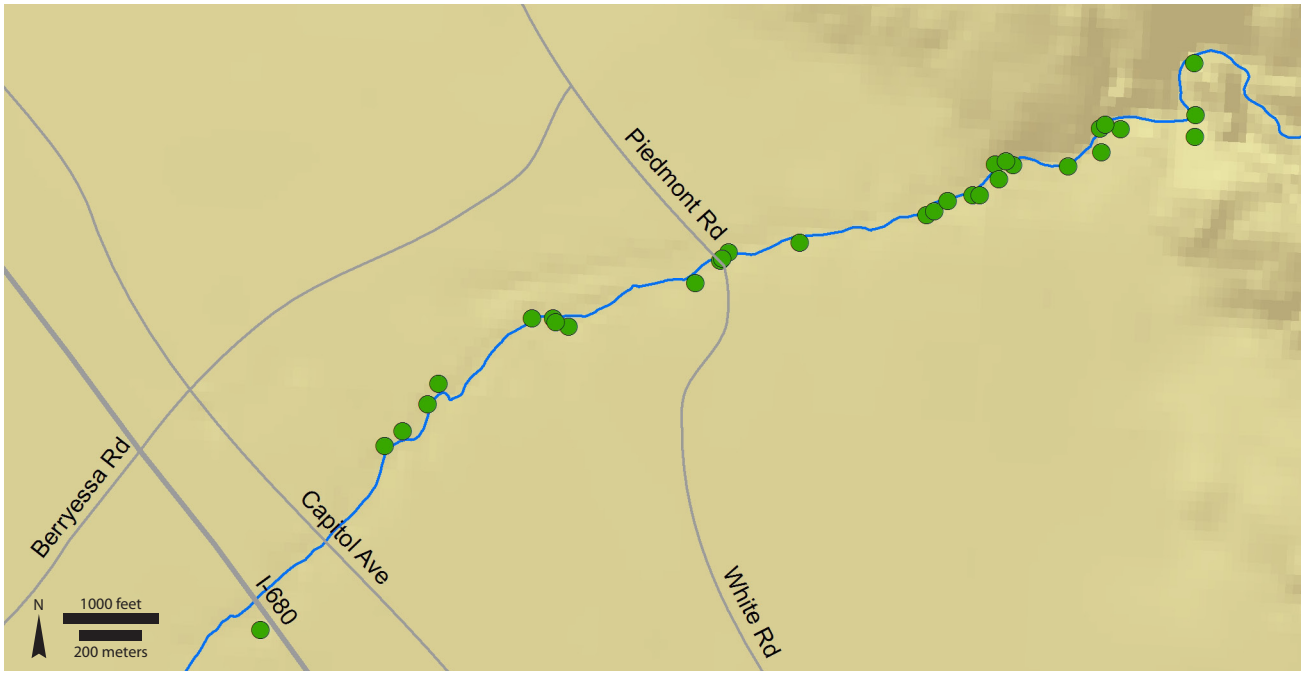

Fig. 15. Sycamores used as bearing trees along Upper Penitencia Creek as recorded on late 19th century surveys. In all, 32 sycamores were recorded between the lower hills and just below Interstate 680.

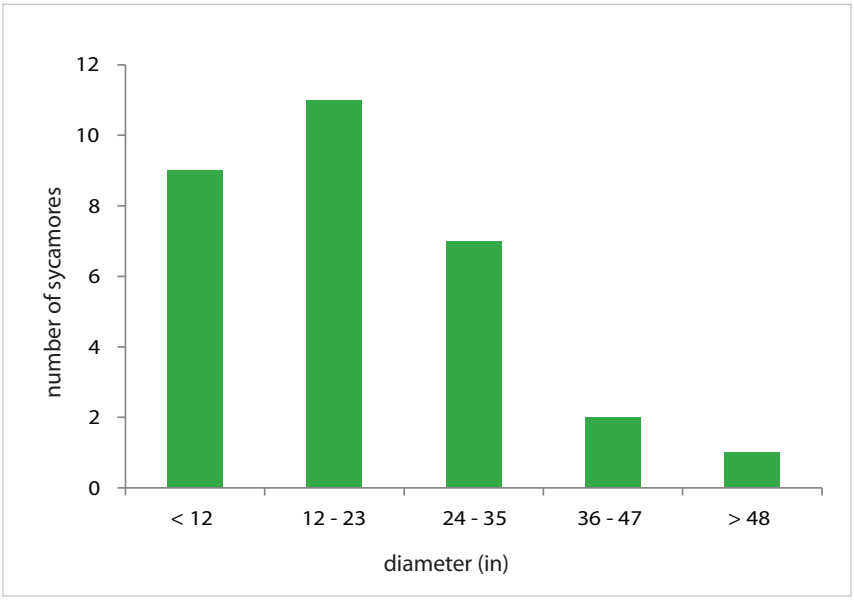

Fig. 16. Size distribution of 19th century sycamores present along Upper Penitencia Creek, using diameters of trees recorded by historical maps.

almost total exclusion of other trees by these surveys suggests sycamore dominance, corresponding with the interpretation of the creek's historically intermittent hydrology along the plain (see page 20).

Furthermore, this depiction of Upper Penitencia Creek's riparian corridor along the valley floor is consistent with observations from recent fieldwork along the creek (DeJager and Martel 2006). DeJager and Martel noted the dominance of sycamores along the creek on the plain upstream of Capitol Avenue even today, and estimated (based on observations from a number of sites) that sycamores often composed 75% of the total riparian canopy cover. While this figure is rough and not directly comparable to our findings (78% of recorded survey trees in these reaches were sycamores), both figures suggest the dominance of sycamores in this area.

The contemporary and historical extents of observed sycamores also match closely; DeJager and Martel note that "sycamores form a nearly continuous riparian forest" from around Capitol Avenue/Penitencia Creek Road upstream. (Most of these observed sycamores are relatively mature trees, whose presence predates contemporary flow conditions.) The absence of historically documented willows, cottonwoods, and alders along this section of the creek is also consistent with recent field observations.

Downstream of the upper Mabury Road crossing, we found no recorded trees along the creek. As a result, it is impossible to determine the historical downstream extent of sycamores. Sycamores may have extended further westward toward the creek's historical terminus: transitions from sycamore riparian forest to willow forested wetlands at creek termini are documented on a number of other Santa Clara Valley creeks (e.g., Guadalupe Creek, Llagas Creek, and Pacheco Creek; Grossinger et al. 2008, Beller et al. 2010). Several large coast live oaks, likely old enough to have been present in the 19th century, are currently found along the creek from the upper Mabury Road crossing downstream to Educational Park Drive, indicating that these trees may have formerly extended futher downstream. Alternatively, this could have represented a shift in canopy character as the creek approached the large willow groves and wetland complex at its terminus.

The historical data outlined above suggest that despite substantial hydrological, geomorphic, and ecological changes to Upper Penitencia Creek, fragments of its historical riparian patterns – in the form of a sycamore-dominated riparian canopy – are still intact. Further historical research may resolve the nature of the riparian forest in the lowest reaches of the creek, between Capitol Avenue and its historical distributary around King Road and the lower Maybury Road crossing.

Conclusion

This study sought to document historical conditions of Upper Penitencia Creek as it flowed across the Santa Clara Valley. This was accomplished through an exhaustive examination, based on archival sources, of available data documenting former habitat patterns and hydrology along the creek (fig. 17).

Our research confirms and advances the historical analyses of the *Coyote Creek Watershed Historical Ecology Study* as well as Bill DeJager and Dan Martel's *Upper Penitencia Creek Feasibility Study*. In contrast to the mixed riparian forest canopy and perennial flow found just upstream in the Alum Rock Park area, on the valley floor Upper Penitencia Creek was characterized by a sycamore-dominated riparian corridor at least to the upstream Mabury Road crossing. Then as now, the creek exhibited a relatively low sinuosity, though with additional side channels no longer found today. Arguably the most major shift over the past two centuries has

Fig. 17. A large, old sycamore and live oak are surrounded by other trees in the riparian corridor along the south side of Upper Penitencia Creek west of Viceroy Way, November 2011.

been in summer flow conditions, from low or no dry season flow across the valley floor to a more perennial hydrology sustained by summer releases and out-of-watershed imports. And perhaps most remarkable of all, the story of how Upper and Lower Penitencia creeks came to be two entirely separate systems is at once more intriguing and more complicated than was previously understood.

These findings are interesting in their own right, as a window into the form and function of the ancestry of the Upper Penitencia Creek we have inherited. Yet it is also possible to identify broader themes and frame them in a regional context. Similarities to other systems in the Santa Clara Valley emerge: like many other creeks in this region, Upper Penitencia Creek was suited to the relatively xeric conditions of Mediterranean-climate Calfornia. Upper Penitencia Creek exhibited habitat heterogeneity, with distinct ecological patches (mixed riparian forest, sycamore woodland, willow-cottonwood forested wetland) varying longitudinally downstream, with often abrupt transitions reflecting shifts in summer baseflow. This complexity was the articulation of a healthy, dynamic creek, suited to the region's dry Mediterranean climate, with capacity to be responsive and resilient to extreme events such as floods and droughts. This study, along with DeJager and Martel's (2006) study, suggests the potential regional importance of expanding our restoration palette to include these types of heterogenous, xeric-adapted systems.

The information contained here does not in and of itself constitute a plan for how to manage Upper Penitencia Creek. It has been, and will continue to be, a dynamic, complex, changing system. What it does provide is an important foundation to contextualize current conditions, and a vocabulary for expressing how we will choose to redesign and enhance the habitat and function of the creek. The information in this report can help scientists and managers articulate and envision what to value on Upper Penitencia Creek today, and what possibilities can be seen for its future.

References

Alviso A. 1861a. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 424-430. *Courtesy of The Bancroft Library, UC Berkeley*.

Alviso F. 1861b. *U.S. v. José María Alviso, Land Case No. 37 ND [Milpitas (also called "Arroyo de los Coches" or "San Miguel")], U.S. District Court, Northern District*. p. 87-96. *Courtesy of The Bancroft Library, UC Berkeley*.

Arbuckle C. 1986. *Clyde Arbuckle's history of San Jose: chronicling San Jose's founding as California's earliest pueblo in 1777, through exciting and tumultuous history which paved the way for today's metropolitan San Jose; the culmination of a lifetime of research*. San Jose, CA: Memorabilia of San Jose.

Ayer SF, Snow J, Herrmann C. ca. 1880. Map accompanying the report of viewers in the matter of the petition of A.F. Umbarger et al. for a change of a public road in... Burnt Maps I-J, p. J-24. *Courtesy of Office of the Santa Clara County Surveyor*.

Becker GS, Reining IJ, Asbury DA, et al. 2007. *San Francisco Estuary watersheds evaluation: identifying promising locations for steelhead restoration in tributaries of the San Francisco Estuary*. Center for Ecosystem Management and Restoration, Oakland, CA.

Beller EE, Grossinger RM, Salomon MN, et al. 2011. *Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. SFEI contribution #641*. San Francisco Estuary Institute, Oakland, CA.

Beller EE, Salomon MN, Grossinger RM. 2010. *Historical vegetation and drainage patterns of western Santa Clara Valley: a technical memorandum describing landscape ecology in Lower Peninsula, West Valley, and Guadalupe Watershed Management Areas. SFEI contribution #622*. San Francisco Estuary Institute, Oakland, CA.

Bernal A. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District.* p. 102. *Courtesy of The Bancroft Library, UC Berkeley*.

Boone LR. 1922. The history of the Santa Clara Valley: the Spanish period. M.A., UC Berkeley, Berkeley, CA.

Bowen JJ. 1865. Plot and description of a tract of land belonging to V. Spreckens, surveyed Oct 2, 1865. Map book C p. 139. *Courtesy of Office of the Santa Clara County Surveyor*.

Brown AK. 2005. *Reconstructing early historical landscapes in the Northern Santa Clara Valley*. Russell K. Skowronek. Santa Clara: Santa Clara University.

Carroll MB. 1903. *Ten years in paradise: leaves from a society reporter's note-book.* San Jose, CA: Press of Popp & Hogan.

Child S. 1916. *A plan for the development of Alum Rock Park (reservation) at San Jose, California*. San Francisco, CA.

Coombe J. 1881. Map of the subdivision of the property of Mr. A.B. Capp, being

part of Pueblo Tract No. 1. Map 751. *Courtesy of Office of the Santa Clara County Surveyor*.

Daily Alta California. 1861. Mountain scenery in Santa Clara County. February 20, 1861. *Courtesy of California Digital Newspaper Collection*.

Day S. 1850. [Map of land claimed by Mr. Branham, including the Sauzal at the base of Penitencia Creek]. *Courtesy of Office of the Santa Clara County Surveyor*.

Day S. 1854. *Field notes of the survey of the exterior boundaries of townships... on the east side of Mount Diablo Meridian, between the first and third standard parallels south, and eighteen miles of range line along the eastern boundaries of townships 13, 14 and 15 south, range 3 east, under contract dated October 31, 1853.* General Land Office. U.S. Department of the Interior, Bureau of Land Management Rectangular Survey, California, Township 7 South, Range 1 East, Vol. R231. p. 489-491, 503-553. *Courtesy of Bureau of Land Management, Sacramento, CA*.

Denamell MB. 1861. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District*. p. 440-452. *Courtesy of The Bancroft Library, UC Berkeley*.

DeJager B, Martel D. 2006. *Upper Penitencia Creek Feasibility Study: draft functional assessment*. U.S. Army Corps of Engineers, San Francisco District, San Francisco, CA.

Drury W, Drury A. 1913. *California tourist guide and handbook: authentic description of routes of travel and points of interest in California*. Berkeley, CA: Western Guidebook Company.

Eld H. 1841. [Route through southern Alameda and northern Santa Clara Counties, California]. *Courtesy of Earth Science and Map Collection, UC Berkeley*.

Evans AS. 1873. *A la California: sketches of life in the golden state*. San Francisco, CA: A.L. Bancroft & Company.

Foote HS. 1888. *Pen pictures from the garden of the world : or, Santa Clara County, California illustrated, containing a history of the county ... & biographical mention of many of its pioneers & also of prominent citizens of to-day*. Chicago, IL: Lewis Pub. Co.

Geological Survey of California. 1865. *Geology, volume 1. Report of progress and synopsis of the field-work, from 1860 to 1864*. Philadelphia, PA: Canton Press of Sherman & Co.

Goodrich L. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District*. p. 109-112. *Courtesy of The Bancroft Library, UC Berkeley*.

Grossinger RM, Askevold RA, Striplen CJ, et al. 2006. *Coyote Creek watershed historical ecology study: Historical condition, landscape change, and restoration potential in the Eastern Santa Clara Valley, California*. SFEI Publication 426, San Francisco Estuary Institute, Oakland, CA.

Grossinger RM, Beller EE, Salomon MN, et al. 2008. *South Santa Clara Valley Historical Ecology Study: Including Soap Lake, the Upper Pajaro River, and Llagas, Uvas-Carnadero, and Pacheco Creeks*. SFEI Publication #558, San Francisco Estuary Institute, Oakland, CA.

Grossinger RM, Striplen CJ, Askevold RA, et al. 2007. Historical landscape ecology of an urbanized California valley: wetlands and woodlands in the Santa Clara Valley. *Landscape Ecology* 22:103-120.

Gudde EG, Bright W. 1998. *California place names : the origin and etymology of current geographical names*. 4th ed., rev. and enl. edition. Berkeley, CA: University of California Press.

Hall F. 1871. *The history of San Jose and surroundings: with biographical sketches of early settlers*. San Francisco, CA: A.L. Bancroft and Co.

Hare GH. 1872. Map of Vicinity of San Jose. San Francisco, CA: Lith. Britton & Rey. *Courtesy of San Jose Public Library, California Room*.

Healy CT. 1860. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 173-194. *Courtesy of The Bancroft Library, UC Berkeley*.

Healy CT. 1861a. A topographical map of the Rancho de Pala: [Calif.] Land Case Map D-513. [1:31,680]. 40 chs. to 1 in. U.S. District Court, Northern District. *Courtesy of The Bancroft Library, UC Berkeley*.

Healy CT. 1861b. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 500-501. *Courtesy of The Bancroft Library, UC Berkeley*.

Henning JP. 1860. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 208-233. *Courtesy of The Bancroft Library, UC Berkeley*.

Healy CT. 1866. Official map of the county of Santa Clara, California, surveyed and compiled by Charles T. Healey. San Francisco, CA: A. Gensoul, Pacific Map Depot. *Courtesy of The Bancroft Library, UC Berkeley*.

Herrmann AT. 1881. [Map of Auzerais, Crighton, and C.E. White tracts, surveyed December 15, 1881]. Map 757-A. *Courtesy of Office of the Santa Clara County Surveyor*.

Herrmann AT. 1902. Map of the I.O.O.F. home tract in the Rancho Pala, County of Santa Clara, state of California. Map book F-2, p. 13. San Jose, CA. *Copy housed in the Santa Clara County Archives; original courtesy of the Santa Clara County Clerk-Recorder*.

Herrmann AT. 1905. Map of the pumping tests made during 1905 in the artesian belt of the Coyote River: Santa Clara County, California. San Jose, Calif. [1:15,840]. 20 ch. to 1 in. *Courtesy of Water Resources Collections and Archives*.

Herrmann Bros. 1885. Map accompanying the report of the viewers in the matter of the petition of A. Randall et al. for a public road. Map book E, p. 32. *Courtesy of Office of the Santa Clara County Surveyor*.

Herrmann Bros. 1890. Official map of the County of Santa Clara, California: compiled from U.S. surveys, county records, and private surveys and the tax-list of 1889, by order of the Hon. Board of Supervisors. *Courtesy of Branner Earth Sciences Library and Map Collections, Stanford University*.

Herrmann Bros. 1895. Reservation tract: part of Pueblo Tract No. 1, San Jose city lands. Map book F, p.46. *Courtesy of Santa Clara County Archives*.

Herrmann C. 1883. Map of a survey of the change of the Alum Rock Fall Road, from the falls to the hotel. Map book E p. 16. *Courtesy of Office of the*

Santa Clara County Surveyor.

Herrmann C. 1884. Map of the survey of an old road leading from the Beryessa Road and along the Penetencia Creek to the City Reservation. Burnt Maps M, p. 10. *Courtesy of Office of the Santa Clara County Surveyor*.

Jordan BA, Annable WK, Watson CC, et al. 2010. Contrasting stream stability characteristics in adjacent urban watersheds: Santa Clara Valley, California. *River Research and Applications* 26:1281-1297.

Keeler-Wolf T, Lewis K, Roye C. 1996. *The definition and location of sycamore alluvial woodland in California*. State of California, The Resources Agency, Department of Fish and Game, Sacramento, CA.

Lapham MH. 1904. *Soil survey of the San Jose area, California*. Washington, DC: Government Printing Office, U.S. Bureau of Soils.

Lewis WJ. 1865. Map of the line of the Western Pacific Railroad Company. Office of the Western Pacific Rail Road Company. San Francisco, CA. *Courtesy of Office of the Santa Clara County Surveyor*.

Malone HC. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District.* p. 95-96. *Courtesy of The Bancroft Library, UC Berkeley*.

McMillan JG. 1891. Map of lands purchased from A.F. Umbarger and C.E. White for a bridge site on the Penitencia Creek. Map no. 723. *Courtesy of Office of the Santa Clara County Surveyor*.

Murphy J. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District*. p. 114. *Courtesy of The Bancroft Library, UC Berkeley*.

Pacific Rural Press. 1902. The irrigator: statistics of California irrigation. June 21, 1902. *Courtesy of California Digital Newspaper Collection*.

Peck S. 1861. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 246-255. *Courtesy of The Bancroft Library, UC Berkeley*.

Pyle JT. 1860. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District.* p. 158-168. *Courtesy of The Bancroft Library, UC Berkeley*.

Quivvy P. 1858. *U.S. v. Charles White, Land Case No. 233 ND [Pala], U.S. District Court, Northern District*. p. 41. *Courtesy of The Bancroft Library, UC Berkeley*.

Revere JW. 1849. *A tour of duty in California*. Joseph N. Balestier. New York, NY: C.S. Francis & Co.

Sacramento Daily Union. 1862. Mineral resources of Santa Clara. June 28, 1862. *Courtesy of California Digital Newspaper Collection*.

Sacramento Daily Union. 1866. [Rancho del Pala]. October 20, 1866. *Courtesy of California Digital Newspaper Collection*.

San Jose Mercury. 1872. The Santa Clara Valley. July 18, 1872.

Sawyer ET. 1922. *History of Santa Clara County, California, with biographical sketches of the leading men and women of the county who have been*

identified with its growth and development from the early days to the present. Los Angeles, CA: Historic Record Co.

SCBWMI (Santa Clara Basin Watershed Management Initiative). 2000. *Watershed characteristics report (volume one)*. Volume One, San Jose, CA.

Scott M. 1985. *The San Francisco Bay Area: a metropolis in perspective*. Berkeley, CA: University of California Press.

Shortridge CM. [1896]1986. *Santa Clara County and its resources : historical, descriptive, statistical, a souvenir of the San Jose mercury, 1896*. Reprint 1896 ed. edition. San Jose, CA: San Jose Historical Museum Association.

Sibrian I. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District.* p. 77-83. *Courtesy of The Bancroft Library, UC Berkeley*.

Sibrian I. ca. 1858. [Map of Milpitas rancho], *in* U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District. Page 73. *Courtesy of The Bancroft Library, UC Berkeley*.

Snyder JO. 1905. Notes on the fishes of the streams flowing into San Francisco Bay. In *Report of the Commissioner of Fisheries for the fiscal year ... and special papers*, ed. U.S. Bureau of Fisheries, 329-338. Washington, DC: Government Printing Office.

Stillwater Sciences. 2006. *Upper Penitencia Creek Limiting Factors Analysis: final technical report*. Prepared for Santa Clara Valley Urban Runoff Pollution Prevention Program, Oakland, CA, Berkeley, CA.

Thompson and West. 1876. *Historical atlas map of Santa Clara County, California: compiled, drawn and published from personal examinations and surveys*. Oakland, CA: Thompson & West.

Thompson GH, Baker GH, Norris TW. 1866. Map of pueblo lands of San Jose [Calif.]: finally confirmed to mayor & common council of the City of San Jose. S[an] F[rancisco], Calif. ca. 1:126,720. *Courtesy of The Bancroft Library, UC Berkeley*.

Tibbetts FH, Kieffer SE. 1921. *Report to Santa Clara Valley Water Conservation Committee on Santa Clara Valley Water Conservation Project*. San Jose, CA.

Tracy FP. 1858. *U.S. v. Nicolás Berreyesa, Land Case No. 388 ND [Milpitas], U.S. District Court, Northern District.* p. 87-89. *Courtesy of The Bancroft Library, UC Berkeley*.

Unknown. ca. 1900a. Penitencia Creek, Alum Rock Park, San Jose, California. *in* Mary Bowden Carroll. 1903. Ten years in paradise: leaves from a society reporter's notebook. San Jose, CA: Press of Popp & Hogan.

Unknown. ca. 1900b. Penitencia Creek near Alum Rock, San Jose. *Courtesy of San Jose Public Library, California Room*.

USDA (U.S. Department of Agriculture), Western Division Laboratory. 1939. [Aerial photos of the Santa Clara Valley] CIV-1939. Scale: 1:20,000. Frames: 284-001 - 291-013. Agricultural Adjustment Administration (AAA).

USDA (U.S. Department of Agriculture). 2009. [Natural color aerial photos of Santa Clara County]. Ground resolution: 1m. National Agriculture

Imagery Program (NAIP). Washington, DC.

U.S. District Court, Northern District. 1839. Plan diseño de un terreno...las Milpitas: [Rancho Pala, Santa Clara Co., Calif.]. Land Case 388, Map D-835. *Courtesy of The Bancroft Library, UC Berkeley*.

U.S. District Court, Northern District. 1840. Plan diseño puerto ó formado por pueblo...en el año del 1840 : [Rancho Milpitas, Santa Clara Co., Calif.]. Land Case 388, Map E-836. *Courtesy of The Bancroft Library, UC Berkeley*.

U.S. District Court, Northern District. ca. 1840a. [Diseño del Pueblo de San Jose.] Land Case Map E-917. [ca. 1:85,312] *Courtesy of The Bancroft Library, UC Berkeley*

U.S. District Court, Northern District. ca. 1840b. [Diseño del Pueblo de San Jose: "Pueblo lands grant," Santa Clara Co., Calif.] Land Case Map E-900. [ca. 1:85,312]. *Courtesy of The Bancroft Library, UC Berkeley*.

U.S. Geological Survey (USGS). 1899. San Jose Quadrangle, California: 15-minute series (Topographic); 1:62,500. 1:62,500 *Courtesy of Earth Sciences & Map Library, UC Berkeley*.

U.S. Geological Survey (USGS). 1913. *Topographic instructions of the United States Geological Survey*. Washington, DC: Government Printing Office.

Wallace J. 1858a. *Field notes of the final survey of the Rancho Pala. E. White, et al., confirmee*. General Land Office. U.S. Department of the Interior, Bureau of Land Management Rectangular Survey, California, Vol. F-15. p. 263-272. *Courtesy of Bureau of Land Management, Sacramento, CA*.

Wallace J. 1858b. Plat of the Pala Rancho, finally confirmed to Ellen R. White, et al., widow, and heirs of Charles White. *Courtesy of Bureau of Land Management*.

White CA. 1983. *A history of the rectangular survey system*. Washington, DC: U.S. Government Printing Office.

Whitney JD. 1873. Map of the region adjacent to the Bay of San Francisco. San Francisco, CA: State Geological Survey of California. *Courtesy of Earth Sciences & Map Library, UC Berkeley*.

Young S, McMurtry R, Stanley-Jones M, et al. 2003. *Watershed assessment report, Chapter 6: assessment of Upper Penitencia subwatershed*. SCBWMI (Santa Clara Basin Watershed Management Initiative), San Jose, CA.